NATURE

No. 4030 SATURDAY, JANUARY 25, 1947 Vol. 159

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Advertisements should be addressed to
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Telephone : Temple Bar 1942

The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

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UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANISATION

IN the debate in the House of Lords on December 3, in which the Government accepted Lord Vansittart's motion for the encouragement of the development of close political and economic relations between the countries of Western Europe, Lord Lindsay spoke eloquently of the importance of relaxing in every way possible the regulations which make travel and the intercourse of minds difficult. He rightly stressed the value of the contribution to the unification of Europe which could come from abundant intercourse between the young; and on the cultural side, he also urged that energetic measures should be taken to deal with the scarcity of books, for books could be a real step towards establishing a common culture in Europe. Though the debate was pervaded with a sense of the ultimate necessity of such steps as Field-Marshal Smuts and Mr. Churchill have urged in recent speeches, no one suggested that a United States of Europe is as yet practical politics. Rather it was realized that there must be established once more that free intercourse of minds out of which creative ideas and action emerge in politics as well as in science and in art.

Something of the same impression came from the debate in the House of Commons on November 22 on the United Nations Educational, Scientific and Cultural Organisation. Quoting from the preamble to the constitution of the Organisation, "Since wars begin in the minds of men, it is in the minds of men that the defences of peace must be reconstructed", Mr. Eric Fletcher urged the importance of more public attention being given to the work of the Organisation which, if backed by an informed public opinion, could, he believed, make a vital contribution to international understanding. He suggested that attacks on illiteracy, on the revision of text-books, and on the general book shortage should be among the first tasks to which the new Organisation could set its hand. The scientific field offers many opportunities for co-operation, and Mr. Fletcher mentioned in particular a publication entitled "The Tasks and Functions of the Secretariat's Division of Natural Science". There is grave danger, he believes, that the United Nations Educational, Scientific and Cultural Organisation may attempt too much. In this he was vigorously supported by Mr. Kenneth Lindsay, who thinks that that has already occurred and that the Preparatory Commission ignored too much the growing points already in existence. Particularly in the scientific field, there are already many international bodies, some of which did not entirely cease to function even during the War. Dr. J. Needham, it is true, has pointed out the numerous gaps that persist, but it may well be that the Educational, Scientific and Cultural Organisation will serve the United Nations best if it is used here as a clearing house with a secretariat and a first-class personnel, and only establishes new bodies with great caution.

Mr. Lindsay pressed for more attention to the pioneer work of the Allied Ministers of Education,

and pointed to the work of the Association of University Professors and Lecturers of Allied Countries in Great Britain as providing a nucleus on which an international body could be built up; such a body would certainly facilitate the fundamental educational work, from the university-level downwards. Other speakers in the debate urged that the Educational, Scientific and Cultural Organisation should keep to practical tasks really within its compass, and especially the restoration of educational systems, the exchange of students, the supply of adequate numbers of text-books and of other educational equipment; although it was also recognized that, if the Organisation is to succeed, there are other matters in which the active interest and support not merely of the Ministers of Education but also of other Government departments would be required.

Miss Ellen Wilkinson, Minister of Education, replying to the debate, promised that a summary or report of the first general conference of the United Nations Educational, Scientific and Cultural Organisation would be issued, either as a White Paper or a Ministry pamphlet. She accepted the principle of concentration on certain practical tasks, where it is a question of money and people and things to be done immediately, but she stoutly championed the idea of wide vision and unrestricted intercourse, rather than narrow conceptions of the ultimate functions of the Organisation. Speaking as chairman of the Preparatory Commission, Miss Wilkinson emphasized the importance of the delegations to the Conference being Government delegates with authority and also having wide influence and support in their own countries.

Miss Wilkinson then spoke specifically of the steps being taken to deal with the appalling destruction of all kinds of educational and scientific apparatus. In view of the world shortage of paper, the possibilities of microfilm in remedying the shortage of books are being explored. The needs of the Continent for scientific apparatus and laboratory equipment were surveyed by the Anglo-American Scientific Equipment Mission at the instance of the Educational, Scientific and Cultural Organisation early this year; it is estimated that material to the value of at least £9 million will be required, chiefly for the smaller and less expensive equipment, to restore the laboratories of the Continent to their pre-war level.

The way in which the Organisation could take over in the scientific and educational world, in the widest sense, the work being done by the United Nations Relief and Rehabilitation Administration has been discussed. Translations and a central pool of scientific information are other matters to which immediate attention is being given, but Miss Wilkinson urged that such immediate and practical tasks are not necessarily the most important. Much more important is that very difficult task of acting as a clearing house of minds; and in urging this, and showing that unless we can instil into the minds of youth standards of value, the sense of a difference between right and wrong, and the conviction that intellectual needs are not mere luxuries, the Minister of Education was in harmony with the whole trend of the debate in the House of Lords.

The Minister's speech is somewhat reassuring, for many have been not unreasonably disturbed at the mass of items with which the agenda for the recent conference of the Educational, Scientific and Cultural Organisation was packed. The value of many of the programmes suggested is undoubted; but their expediency at the present time can be seriously questioned. Not all of those specifically mentioned by the Minister can be regarded as so urgently important as measures to deal with the shortage of books, keenly felt even in British universities and even more on the Continent. Repair and replacement of the buildings, equipment, and libraries of great centres of learning destroyed during the War; the filling of the many gaps in sets of learned periodicals held by research and learned institutions of all kinds throughout the world, on which the research worker depends; and the freeing of scientific publications and of the exchange of students and research workers are the really urgent problems. On the speedy solution of them depends that cross-fertilization of mind, and that wider outlook and fuller understanding across frontiers, out of which must come slowly the thought and purpose which will shape the new political institutions and organs of co-operation needed by the world.

Miss Wilkinson recognized that such practical tasks cost money; it has been estimated that educational relief on the proper scale in Western Europe alone would cost £50,000,000. None the less, no wide discussion of general themes or ideas will avert a feeling of frustration and profound disappointment if the first conference of the Organisation does not result in a real attack, supplied liberally with funds, on educational relief in Europe. The Educational, Scientific and Cultural Organisation is primarily a piece of machinery, and it will best secure the support of public opinion and avoid the relative futility of the Committee on Intellectual Co-operation if it promotes such practical measures as have been mentioned. The whole trend of the House of Commons debate was behind such a view of the primary activities of the Organisation, and reflected the concern which the listing of seventy projects as of special urgency in the progress report of the Preparatory Commission, as well as the representation on a number of the committees, had engendered. The sense of the debate was quite opposed to the programme of philosophical collaboration outlined in the preparatory report, and on which Dr. Julian Huxley had spoken as a long-range aim. That can only be achieved after the barriers to the exchange of thought and knowledge are removed, and when the contact of mind with mind, and experience in working together in pursuit of common aims, lead to a fresh synthesis and formulation of the values of civilization.

No one could suggest that in the debate there was any desire to prolong or intensify ideological differences: in spite of the insistence on the values of Western civilization, there was just as evident a desire to see Soviet Russia fully associated with the Educational, Scientific and Cultural Organisation, as found expression at the conference last July on the

Organisation and the Universities arranged by the British Association, a report of which has now appeared in *The Advancement of Science* (4, No. 13; 1946). Sir Alfred Zimmern, in his opening address to the conference, rightly affirmed that the Organisation is bound to respect intellectual freedom and the unrestricted pursuit of truth, and that in its dealings with universities and other learned bodies it should avoid anything savouring of an attempt at control. The safeguarding of these values is indeed a major aim of the Organisation, and one in which it can count on the support of universities in every part of the world. But although Sir Alfred went on to discuss the form which co-operation between the universities and the Organisation would assume in practice, as well as that between the Organisation and other international associations such as the Council of Scientific Unions, few of the other speakers at the conference appear to have kept the discussion at a severely practical level.

The fact that the conference was also considering the report of the British Association's Committee on Post-War University Education may be partly responsible for this. Discussion was thereby drawn into a debate between two schools of thought: those who hold, like Mr. Bruce Truscot, that the purpose of universities is both the advancement and dissemination of knowledge, and those who, like Senor Ortega y Gasset, reject the research function and maintain that universities exist for the maintenance and propagation of broad cultural values and for the creation of an educated *élite*. We need, indeed, as Prof. Dobrée said, a far larger number of men and women, of university training, able to grasp ideas and aware of the conditions upon which our highly complex life is lived. Fuller and closer contacts between the universities in Great Britain and in other countries may well assist the development of new and more effective means of raising the general educational level and making international co-operation easier. But at the moment that task is surely second to that of getting the educational systems of Europe going again and repairing the havoc of war. Generous tribute was indeed paid by Prof. Jean Timmermans and others to the work of the Minister of Education and of the Association of University Professors and Lecturers of Allied Countries in Great Britain, the forerunner of the International Association; but little was said about the urgency of immediate educational reconstruction in Europe.

To compare the published report of the conference for the establishment of the United Nations Educational, Scientific and Cultural Organisation held in London in November 1945 with the programme which was presented to the Preparatory Commission in July (cf. *Nature*, August 31, p. 298) is to realize that there is some solid foundation for the belief that the priorities have been changed. It is true that there is no less emphasis laid on the importance of promoting increased co-operation and contact between philosophers, men of science, humanists, historians and others, and of the free and unrestricted exchange of ideas and knowledge, to the value of which both the Prime Minister and Miss Wilkinson testified at that conference, and which found expression in particular in the resolution concerning plans for a working arrangement between the Organisation and the International Council of Scientific Unions. The task of restoring and extending the means through which men of science of all lands may exchange information and work together for the advancement of knowledge and for its application to human needs is still recognized as urgent; but one misses in the later programme the sense of urgency, apparent, for example, in the instrument establishing the Preparatory Commission, which charged the Commission to appoint a special technical sub-committee to examine the problems relating to the educational, scientific and cultural needs of the countries devastated by the War, with a pointed reference to immediate action.

The original conference was fully aware of the urgency of such immediate practical problems, and was not anxious to establish fresh bodies. On the contrary, many speeches indicated the desire to build on, and to develop, existing institutions wherever possible. If, therefore, enthusiasm for the immense contribution which the United Nations Educational, Scientific and Cultural Organisation can make ultimately by promoting intelligent co-operation throughout the world, at all levels, seems to have led the Preparatory Commission rather astray from some of the more limited, immediately practicable objectives, there is reason for hope that the Paris Conference has redressed the balance. It may be found, when the promised report appears, that ideals and long-term policy have been harmonized with an immediate practical programme directed to assist the reconstruction of European educational systems. Outside the Organisation itself, indeed, support is already forthcoming for practical measures—the recent appropriation to the Organisation from the American Chemical Society for promoting the exchange of chemists and chemical engineers between different countries is one example—and it will be noted that the reconstruction of education in Europe was indeed placed first by the Preparatory Commission on its list of programmes. It is from the demonstration of its ability to minister to these imperative practical needs that the Organisation will draw the public support and understanding necessary for the formulation and execution of wider and more far-reaching plans for bringing the nations together in cultural and intellectual co-operation, and focusing the full force of human intelligence on the task of forging a peaceful co-operative community.

These immediate tasks are in fact but the stepping-stones from which the Organisation should move forward to develop and increase the means of communication between its members, to foster the unrestricted pursuit of truth and the free exchange of thought out of which may ultimately develop something of a world community, and the creative thought which will shape the appropriate instruments of world order to serve the needs of modern society. Neither education nor research can, however, be unifying forces in the world, until these first steps have been taken, and on them our attention should for the moment be focused.

BACTERIOLOGY AND IMMUNITY

Topley and Wilson's Principles of Bacteriology and Immunity

Third edition, revised by Prof. G. S. Wilson and Prof. A. A. Miles. Vol. 1. Pp. xi + 970 + xliv. Vol. 2. Pp. viii + 971–2,054 + xliv. (London: Edward Arnold and Co., 1946.) 2 vols., 60*s*. net.

THIS edition, the third in seventeen years, following four printings of the first and seven of the second edition, indicates a large and steady demand for the work. The late Prof. Topley had withdrawn from authorship, and the latest revision has been undertaken by Profs. Wilson and Miles. The plan of the work, which is divided into four parts in two volumes of about a thousand pages each, has remained as before.

Part 1, by way of introduction, treats of "General Bacteriology", including the history of the science, bacterial morphology and metabolism in their broad aspects, with subsequent chapters on matters of practical interest to the hygienist and physician concerning disinfection and what may be summed up as chemotherapy. Then the phenomena of antigens and antibodies are considered, and this part closes with sections on bacterial variation, classification and the bacteriophage. Part 2, headed "Systematic Bacteriology", commences with a short description of methods of obtaining pure cultures of bacteria and identifying them. Following this, a series of chapters deal with the various groups of bacteria in a sequence which would probably not be used in teaching the subject, since it begins with Actinomyces, then goes on to *Erysipelothrix* and *Listerella*, next to the tubercle bacillus group, diphtheroids, anaerobic or micro-aerophilic Gram-negative bacilli of the Fusiformis group, etc., while *Streptococcus* and *Staphylococcus* come later. This part, which finishes with the general properties of the animal viruses, comprises a most extensive collection of the characters of a very large series of bacteria and will prove of much use to workers in the fields of veterinary and economic bacteriology as well as to medical bacteriologists. Part 3, which occupies three hundred pages, is concerned with "Infection and Resistance". These important subjects are considered very fully and with a wealth of detail. Part 4, the final division of the work, is entitled "The Application of Bacteriology to Medicine and Hygiene". Here the chapter headings correspond to a considerable extent with those in Part 2, and much information is given for clinicians and administrators about the diseases caused by the pathogenic members of the groups discussed earlier. But, of course, complete correspondence is impossible, since, for example, suppuration is due to a wide variety of organisms. Toward one third of the way through the list one finds in sequence chapters on "Cholera", "Meningitis", "Gonorrhœa", "Scarlet Fever and other Diseases due to Hæmolytic Streptococci", "Pyogenic and Wound Infections", "The Bacteriology of Rheumatic Infections and of Endocarditis". This indicates that meanwhile only piecemeal treatment of bacteriology is possible. Such is likely to remain the case until 'general' bacteriology is studied for its own sake and the chief interest ceases to be the production by a given organism of a specific disease or some particular chemical reaction. However, it may be argued whether the most suitable arrangement is secured by separating by more than eight hundred pages consideration of the microscopic and cultural characters of the tubercle bacillus and the diphtheria bacillus from the sections on tuberculosis and diphtheria; after all, the production of these diseases is the most noteworthy characteristic of the two organisms. Accordingly, it will be clear that the work is essentially one for reference. To the practising bacteriologist the book is invaluable; it gives very full lists of publications, and the attention paid to recent literature effects a great saving in the reader's time by indicating what he ought to consult in the original. It may, of course, be considered captious to criticize the book for what it does not contain, but, like a number of other text-books on bacteriology in English, it omits very largely details of procedures.

While it is self-evident that skill in bacteriological methods cannot be acquired except by practical work in the laboratory, nevertheless a considerable amount of description and specification in print is required for reference. Also, advances in knowledge can come only through the channel of experimental methods. Therefore, it is to be regretted that no companion volume is available dealing more extensively with the authors' laboratory practice. A further loss of another kind is entailed by limiting consideration to the ordinary bacteria, spirochætes, rickettsiæ and viruses, while omitting pathogenic Protozoa and Fungi. The pathogenic Protozoa, which are so like many of these other organisms in their effects on the living body of the host, and which are studied by essentially similar techniques, could with great advantage have been included. Discussion on the causes of bacillary dysentery and exclusion of amœbic dysentery is a case in point. Also, any exposition of chemotherapy must suffer from a presentation which, with the limitations imposed, cannot help devoting chief attention to the sulphonamides and penicillin. In connexion with chemotherapy one wonders what is the authority for the statement (p. 155) that Ehrlich's great pioneer work "started in 1905 with a systematic search for a cure for syphilis". The reviewer remembers well remarks made by Ehrlich (about 1906) emphasizing how the experimental pharmacologists up to that time had chiefly concentrated on toxicology, while his own aim was "kranke Tiere heilen".

The book as a whole is emphatically not for the use of the higher forms in schools. So far as undergraduate and postgraduate students preparing for examinations are concerned, one feels that a few selected chapters should be prescribed as a training on how to assess the literature critically. However, we owe a debt equally to the authors and the publishers of "Topley and Wilson's Principles" for making this mass of up-to-date information available at a very modest price. The authors must also be congratulated on the organisation which has enabled them to marshall the almost overwhelming mass of printed matter which has had to be dealt with in its preparation. A conservative estimate places the contents at about 1,200,000 words, while the Medical Research Council's "System of Bacteriology" in nine volumes contains about two million words. It is unfortunate that exigencies imposed on the production of a book such as the "Principles" make it necessary to deal with an actively growing subject like bacteriology in this way. A series of monographs would, we think, serve much better the interests of users. These separate volumes could then be brought up to date independently as advances required.

C. H. BROWNING

THE AIRY INTEGRAL

British Association for the Advancement of Science
Mathematical Tables. Part-Volume B: The Airy Integral, giving Tables of Solutions of the Differential Equation $y'' = xy$. Prepared by J. C. P. Miller. Pp. B.56. (Cambridge: At the University Press, 1946.) 10*s*. net.

THE tabulation in this volume is mainly concerned with the function $Ai(x)$ and its derivative, and before discussing the actual details of the tables, it is instructive to recall the history of the function.

A little over one hundred years ago, in calculations relating to the light-intensity in the neighbourhood of a caustic, Airy was confronted with the integral

$$W = \int_{\bullet}^{\infty} \cos \tfrac{1}{2}\pi\,(w^3 - mw)\,dw,$$

and succeeded in producing a 5-decimal table for values of m ranging between $\pm$ 4, later extended to $\pm$ 5·6.

It can be deduced that W satisfies the differential equation

$$\frac{d^2W}{dm^2} = -\frac{1}{12}\pi^2 m\,W,$$

and hence that the problem of computing it is effectively that of computing the solutions of the second order differential equation

$$\frac{d^2y}{dx^2} = xy.$$

The form of this last equation suggests that its solutions are closely allied to Bessel functions of a certain order, and denoting them by $Ai(x)$ and $Bi(x)$, it may be shown, for example, that when x is real and positive,

$$Ai\,(-x) = \tfrac{1}{3}x^{\frac{1}{2}}\{J_{-\frac{1}{3}}(\xi) + J_{\frac{1}{3}}(\xi)\}$$
$$Bi\,(-x) = (\tfrac{1}{3}x)^{\frac{1}{2}}\{J_{-\frac{1}{3}}(\xi) - J_{\frac{1}{3}}(\xi)\}$$

where $\xi = \frac{2}{3}x^{3/2}$, with similar results for positive arguments in terms of modified functions.

Recently the demand for tables of the Airy integral has revived; a revival closely connected with the simplicity of the differential equation above, and in virtue of which the British Association, through its tables committee, has prepared this volume (issued as Part-Volume *B*, in conjunction with a volume dealing with the tabulation of Legendre polynomials).

It is provided with a substantial introduction discussing the history of the function, the formulæ and equations involved, and the methods of computing and checking. This occupies some fifteen pages and is followed by tables of $Ai(x)$ and $Ai'(x)$, for the range $x = -20$ to $x = 2$, at intervals of 0·01, the entries being to eight decimal places, with second differences.

Subsidiary tables of the logarithms, zeros and turning values of the functions are also included, and similar results for the Bi functions for the range $-10{\cdot}0\ (0{\cdot}1) + 2{\cdot}5$ are provided. Finally there are eight pages of tables of auxiliary functions, with definitions and formulæ.

The whole book is beautifully produced and does its authors great credit. It is interesting, in conclusion, to note that Airy's original computations, in spite of the exceedingly laborious work which they involved, were almost entirely devoid of error.

J. H. PEARCE

MAP PROJECTIONS

Map Projections
By George P. Kellaway. Pp. viii + 128. (London: Methuen and Co., Ltd., 1946.) 10*s*. 6*d*. net.

WE welcome a book whose "aim is to provide students of geography with a logical treatment of the commoner map projections". A careful study leaves no doubt of its value as a contribution to the teaching of the subject: the plan is well conceived and skilfully executed.

The earth sphere, latitude and longitude are compressed into four pages, which lead to discussion of the fundamental problem of representation of the earth on flat maps. There is a double classification based on: (1) nature—perspective, geometrical and conventional; (2) construction—on plane, cylinder or cone.

Part 1 begins with polar maps: the order gnomonic, stereographic, orthographic is surprising; there is something to be said for beginning with the sphere as ordinarily seen. Cylindricals follow, and here the discussion of Cassini's is particularly welcome though the construction is not detailed, probably because it is too difficult for those for whom the book is intended. Conicals, ending with Bonne's, complete the geometrical types. Conventionals open with Sanson-Flamsteed. Aitoff receives due notice as an improvement on Mollweide.

The plan of treatment in each case is: (1) mathematical basis; (2) statistical examination of properties at regular latitude intervals; (3) summary of general properties; (4) limitations; (5) construction. The statistical treatment leads to the study of limitations. This is very thoroughly done. Perhaps, after full treatment in one case and a beginning in others, something might, with advantage, have been left for the student to do; on the other hand, much labour has provided some very acceptable reference material.

Part 2 deals with equatorial zenithals and obliques.

The outstanding impression is that the author is deeply concerned, and quite rightly, that the student should realize the importance, in dealing with approximations, of considering the degree of accuracy attained. One would like to think of non-mathematical geographers at school or university being at home with the mathematical work, in these days of numerical trigonometry to School Certificate. To follow the manipulative work would be a severe tax; at worst, the student can take it as read, pay due attention to the statistical data and construct according to instructions. No student can really be said to have studied map projections without constructive work.

The book ends with an admirable discussion of the use of various projections and a collection of representative questions set by university examining boards. Could we not give them a lead in setting questions concerned with travel, and would it not be worth while for examiners to ask a candidate to construct rather than write about projections, at least sometimes?

In conclusion, the reviewer has read the book with real pleasure: he feels no hesitation in recommending its careful study by those seeking a stimulating text-book on the subject or a worthy addition to the geographical library. He congratulates author, publisher and printers on an excellent production.

A. HINCKLEY

The United Nations

A Handbook on the New World Organisation. By Louis Dolivet. Pp. 144. (London: Phœnix House, Ltd., 1946.) 6s. net.

IT is probably true to say that the prestige of the United Nations Organisation has fallen as much in twelve months as that of the League of Nations fell in as many years. Disillusionment and bewilderment are as widespread as the realization that, for all such disappointment, the diagnosis of the founders of the Organisation remains correct. It is still true that Western civilization cannot indefinitely sustain the strain imposed upon it by the conflicting interests of the Great Powers.

If, however, this situation is to be retrieved and the United Nations Organisation is to succeed in its objectives, it must have the firm support of individual men and women throughout the world. That support must be based on clear understanding of the ramifications of the Organisation, the diversity of its problems and the mechanics of its operations. Mr. Dolivet's handbook is an objective contribution to that end. It is not a commentary, but a conscientious and workman-like attempt to give a factual picture of the actual structure and purposes of the Organisation. The book is readable, and although in some respects incomplete, being free from any attempt to record achievements or current controversies, it should assist the ordinary citizen to arrive at some independent judgment for himself. The appendixes include the Charter of the United Nations, the Statute of the International Court of Justice, and the names of representatives on the Security Council, the Military Staff Committee, the Atomic Energy Commission, and the delegates to the Economic and Social Council and to the First Assembly. If to future editions there could be added similar factual presentations of the relations with, and functions of, the Educational, Scientific and Cultural Organisation, the Food and Agricultural Organisation, and the like, which are in this edition rather summarily discussed, and of the trusteeship developments, it could well become a reference book that the ordinary citizen would be glad to have at hand. R. B.

Les Liquides Dispersifs et leurs Applications

Par Dr. G. Ahier. Pp. 88., (Pâris: Jouve et Cie., 1940.)

OWING to war conditions, this interesting monograph has only recently become available in Great Britain. It forms a useful summary of a great deal of work on the applications of liquids of high dispersivity, especially to the construction of Christiansen filters (*C.R. Acad. Sci., Paris*, 202, 1775 (1936); 205, 37 (1937); 206, 203 (1938)).

Christiansen filters consist essentially of a powdered solid immersed in a liquid of similar refractive index but different dispersivity. For one wave-length, the refractive indices are equal; the mixture is then homogeneous and transparent to this wave-length, while all other wave-lengths are scattered. The literature records the use of a number of such filters. Dr. Ahier's book discusses the theory of these filters, and derives formulæ which may assist in their construction. He also describes fully a series of liquids and solids with which he assembled filters which selected narrow bands of wave-lengths, from the visible region down to 1850 A. Careful manipulation renders it possible to isolate bands, which, in some cases, were only 3 A. wide. The merits and defects of Christiansen filters are compared with those of coloured filters and monochromators. In general, Christiansen filters are cheaper, more easily made, and more satisfactory from the point of view of both selectivity and optical density.

Dr. Ahier's book should be useful to workers requiring light filters, partly as a practical handbook, and partly as a review of the subject, including the infra-red region. G. J. MINKOFF

Chemical Thermodynamics

By Dr. J. A. V. Butler. Fourth edition. Pp. xvi+570. (London: Macmillan and Co., Ltd., 1946.) 12s. 6d.

IN this book, the author has brought together in one volume the two parts of his introduction to thermodynamics, which were formerly published separately. The first part gives a straightforward and elementary account of the first and second laws, and their application, with the emphasis towards electrochemistry. The second part, which is considerably more advanced, deals with the more important thermodynamic functions and the third law, and their applications. This part has been revised and brought up to date, and a good deal of new material added. The revision could, with advantage, have been extended to Part 1; even the youngest student may, in this atomic age, raise his eyebrows at the statement on p. 4 that "According to some modern physical theories, matter and energy are interconvertible. If this were substantiated, the Conservation of Energy would be replaced by a wider principle of the Conservation of Mass + Energy." There might also, with advantage, have been a closer synthesis of the text of the two parts.

The book contains a good deal more than its title implies, and discussions of detailed mechanisms are frequently included. This adds considerably to the value of the book, since it gets down to fundamentals. In particular, the author writes interestingly and well on the subjects in which he has made original contributions, such as the kinetic theory of the electrode processes, or the mechanism of over-potential. There is a large number of well-selected examples, many of which are worked out; and a short but very clear account of the application of statistical methods to the determination of thermodynamic functions, by the late Dr. W. J. C. Orr, has been added as an appendix. The book should continue to prove a useful and stimulating introduction to the subject.

F. P. BOWDEN

General Mathematics

By Clement V. Durell. Vol. 1. Pp. xv+312+xlvii. Vol. 2. Pp. xxxi+324+xl. (London: G. Bell and Sons, Ltd., 1946.) 5s. without Answers; 5s. 6d. with Answers, each Vol.

AS Mr. Durell rightly says in his preface, "elementary mathematics should be treated as a single subject". The course embodies many modern ideas of teaching designed to meet the expanding and changing needs of post-war secondary schools. It deals with arithmetic, algebra, geometry and trigonometry, and covers all the requirements laid down in the current syllabuses of the various School Certificate examining authorities.

Each book contains many exercises which are classified into two main groups: a first course, and a parallel course. The first is intended for all pupils, while the second provides extra practice. Useful test papers and revision exercises are supplied, together with answers to all exercises.

THE 'CYTOGENETICS' OF BLACK AND WHITE GUINEA PIG SKIN

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IT is an obvious empirical fact that the differentiated cells of the adult organism, if they are capable of dividing at all, 'breed true' and preserve for ever in cellular inheritance their specificity of histological type. Even under the regime of tissue culture, in which a cell lineage may well comprise a hundred generations, there is no reduction of embryological rank, and no degradation of histological specificity that is not a mere matter of 'nurture' and reversible at will. What is the mechanism of conservative inheritance in the cell lineages generated by mere asexual fission? An attempt will be made to answer this question by special reference to two cytogenetically distinct but closely related types of cell: those of the 'white' and 'black' epidermal epithelia of guinea pigs' skin. It will be suggested that the inherited difference between them is due to the possession by the black epidermis of a cytoplasmic self-reproducing system concerned with melanogenesis that has some of the properties of what are usually called 'viruses'. Analysis of the type we have undertaken is, indeed, only made possible by the circumstance that black skin is capable of 'infecting' white, and endowing it with its own cellular phenotype; a process which is in some respects analogous to a cross between sexual organisms, and which has the same methodological significance for the study of cellular heredity as the phenomenon of segregation has for Mendelian genetics.

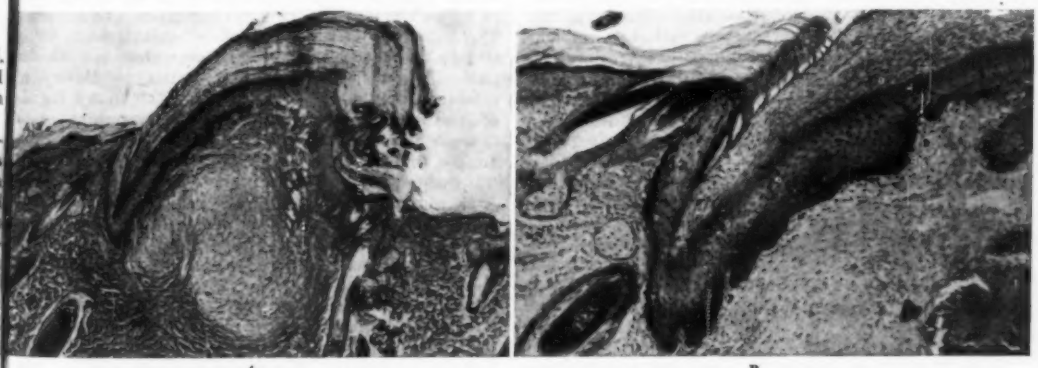
The skin that bears black hairs in a spotted black-and-white guinea pig is itself black in colour. This is because the basal layer cells of its epidermis contain melanin granules. (In rabbits and mice, by contrast, any apparent pigmentation of the skin itself is due to melanin granules housed in the hair follicles alone.) It has been known for fifty years[1,2] that if black guinea pig skin is grafted to a white area on the same animal, a process that may non-committally be called 'infection' takes place: the white skin that surrounds the black graft blackens centrifugally, though the hairs that grow on infected white skin almost invariably stay white. Conversely, white skin grafted to a black area in due course blackens.

Loeb's explanation[3] of the phenomenon is as follows. "The pigmented epidermis is the stronger one"; and because of the physiological disturbance entailed by grafting, it "asserts its authority over the white epithelium", and in the "struggle" that ensues, it wins. Bleached of its metaphorical colourings, the theory amounts to this: for reasons not yet clear, black skin grows into and displaces white[4].

There is no convincing histological evidence that any such process of invasive replacement takes place, save perhaps in the irrelevant special case in which a white graft from one guinea pig (a homograft) is transplanted to a black area on another. We have now conclusive evidence that no replacement occurs. For if the white epithelium of the lunula of a white claw[4] is transplanted to a black area on the skin of the chest, it promptly blackens and produces a jet black claw in the normal skin area (Figs. *A*, *B*). White sole-of-foot or vaginal epithelium transplanted to black areas of dorsal skin likewise promptly blacken, while retaining all their other easily recognizable graft-specific characters, such as the high growth-rate and dense stratum corneum of the sole-of-foot graft, from which a thick pad of compact cuticle may be removed weekly. Moreover, if a white sole-of-foot graft is caused to blacken by grafting to a black area of dorsal skin, it may then be removed and returned to its original surroundings; whereupon the white sole is blackened at second hand by something evidently derived in the first instance from dorsal skin. Results such as these must be held to refute the hypothesis of cellular replacement. If, for example, black dorsal skin epithelium had in fact replaced white claw-forming epithelium, it could scarcely be expected to form a black claw. *Mutatis mutandis*, the same applies to sole-of-foot and vaginal grafts.

Other hypotheses may now be considered.

(1) The blackening of white skin around a black graft is due to the simple diffusion from cell to cell of enzymes or co-enzymes concerned with melanogenesis. In principle, this does not differ from the outward diffusion of a black dye from the graft, supposing that its epithelium were black merely because it had been stained by a black vital dye.



A *B*

(*A*) VERTICAL SECTION THROUGH A BLACKENED CLAW THAT HAS DEVELOPED FROM A SMALL GRAFT OF WHITE LUNULAR EPITHELIUM 33 DAYS AFTER TRANSPLANTATION TO THE BLACK SKIN OF THE CHEST. THE BASAL LAYERS OF THE CLAW EPITHELIUM AND THE CLAW SUBSTANCE ITSELF ARE LOADED WITH MELANIN GRANULES. HÆMATOXYLIN AND VAN GIESON. (*B*) A VIEW IN HIGHER POWER OF THE CLAW-SKIN JUNCTION: FROM A NEIGHBOURING SECTION STAINED WITH EHRLICH'S HÆMATOXYLIN AND ORANGE-G. THE UNIFORM INFECTIVE PIGMENTATION OF THE CLAW EPITHELIUM IS OBVIOUS. NOTE THE ABRUPT TRANSITION BETWEEN SKIN AND CLAW EPITHELIUM, AS INDICATED BY THE CHANGE IN THE STRUCTURE OF THE STRATUM CORNEUM

This hypothesis is untenable because the 'blackness' of artificially blackened white skin becomes a heritable characteristic of its cells. The induced blackness of even so mitotically active an epithelium as that of the sole does not diminish during the dozens of cellular generations through which it must pass in a period of three or four months. In certain circumstances, indeed, it may increase. Moreover, as Fessler first showed[6], if part of the blackened annulus surrounding a black-in-white graft is removed and transferred to a white area, it duly infects the surrounding white skin; and part of this newly formed blackened annulus may in turn blacken its surroundings if grafted to a white area elsewhere. In short: whatever maintains the formation of melanin granules in artificially blackened white skin multiplies with the cells that house it.

(2) A second explanation, therefore, is that the process of contagious infective blackening is produced by the diffusion from black cells into white of a self-reproducing entity that is part of the normal equipment of cytogenetically black cells. This entity spreads like a virus from cell to cell, possibly across the cytoplasmic bridges that are said to unite epidermal cells of the prickle layer; and, being self-reproducing, brings about a change in the white epidermal cells that is thereafter permanently conserved in cellular heredity. It is irrelevant to this interpretation whether the postulated entity is an enzyme, co-enzyme, enzyme vehicle, or colloidal micelle of the 'microsome' type[7]. The point is that it must be supposed to reproduce itself. There are two reasons for supposing that any such entity must be housed in the cytoplasm: (*a*) it must evidently come out of the nucleus, if stationed there, to infect a neighbouring cell; and (*b*) one is not yet entitled to suppose that black and white epidermal cells of the same individual have different complements of nuclear genes. Yet there is no doubt that nuclear genes *do* initiate pigmentation and govern the pattern of its distribution; and we are led to suggest, by analogy with the known behaviour of the 'cytogenes' of yeasts[8,9], that the cytoplasmic factor is gene-initiated but not gene-maintained. Indeed, it is difficult to conceive how the different cell-races of the individual body come to acquire their specificity of histological type, and to maintain it indefinitely in cellular heredity, without postulating the existence of such self-reproducing bodies in the cytoplasm. They may initially have been called into being by some specific act of co-operation between nuclear genes and an external 'morphogenetic' stimulus; but thereafter they maintain themselves autonomously in the cytoplasm. It was to examine a hypothesis of this type that the experiments described here were done; and it was the speculations of Darlington[10] and Haddow[11] that set us thinking on these lines.

There are already several candidates for admission to the status of self-reproducing cytoplasmic 'genes' or proprietary viruses, namely, 'cytogenes', 'plasmagenes'[10], and factors of the type described by Sonneborn[12]; and the idea that such factors play a determinative part in somatic cellular differentiation and heredity is far from new[7,9,11,13]. The inherited difference between black and white epidermal cells is a test case for the following reasons: (i) the two cell types are cytogenetically very similar; (ii) they are nevertheless cytogenetically distinct, and in a superficially obvious way; (iii) black and white epidermal cells can establish just that intimate cytoplasmic contact that may in most cases be necessary for infection to take place. It may prove possible to strengthen our hypothesis by showing that the infective agent that turns white cells black can be introduced into white cells in cell-free extract. Tests of this type are in their early stages, and they have not yet been successful. It seems unlikely that cells of other types should lend themselves so easily to experiments on infective transformation. One could scarcely hope to turn a liver cell, say, into a cell of thyroid epithelium; but it might not prove impossible to endow an undifferentiated fibroblast with osteogenic power.

(3) It is only by analogy with the behaviour of 'viruses'[10] and the cytoplasmic factors of yeasts[8,9] that we have been led to suggest that the infective agent we are dealing with is *itself* self-reproducing. By analogy with what the embryologist has called 'homoiogenetic induction'[14] we might equally well liken it to an 'evocator', that is, to a substance that merely *initiates* the formation of such self-reproducing bodies in the cytoplasm and, consequently, a change of cellular phenotype that is thereafter self-sustained. Now viruses multiply only in association with living cells; and some viruses, like our own candidate, can only multiply in cells of a very restricted type. (As will be shown later, the epidermal epithelium of the tongue is not overtly infectable.) To show that the infective agent we are dealing with is 'really' self-reproducing, we cannot but introduce it into cells of the type that it is known to infect, and show that it multiplies there; in other words, perform the very test that fails to disqualify the alternative view that it is 'really' a morphogenetic hormone. We could, of course, distinguish between virus and evocator by an arbitrary act of definition—as by saying that viruses are always associated with nucleo-proteins and evocators with sterolic compounds; but to attempt to do so before we are much clearer about the form which such a definition had best be made to take might be a real misfortune, born of a deep-seated but perhaps mistaken belief in the propriety of 'always defining one's terms'. All we can say is that the properties of our infective agent relate it more closely to the things which people who study 'viruses' call by that name. For example, black skin *homo*grafts (see above) do not elicit a blackening reaction when grafted to white skin[15]; even, we find, when grafted in such low dosage[16] that they should have time, before their eventual destruction, to infect the neighbouring epidermal cells of the host. The infective agent is therefore iso-antigenic, or is closely associated with something that is. This is perfectly consistent with a virus-type theory of infection, for reasons that involve too many details of the theory of transplantation immunity to be discussed here; but less obviously consistent with a simple 'evocator' theory, since most evocators are not even species-specific in their action.

Pending the publication of a full report, we may take this opportunity of mentioning some of our other experimental findings. (*a*) White tongue epithelium does not blacken in a black skin environment. Even months after grafting, the margin of contact between black skin epithelium and white tongue epithelium (with its characteristic cuticle, and without granular layer) may be distinguished to a cellular boundary. Tongue epithelium may be cytogenetically too far removed from that of skin for such a process of infection to take place; and it may be relevant that we have not so far seen a naturally occurring pigmentation in the tongue of

the guinea pig, although feet, claws, and vagina are pigmented in some individuals. (*b*) The process of infection occurs mainly in the basal layers of the superficial (as opposed to follicular) epidermis, so that the hairs borne by artificially blackened white skin tend to remain white, even after manipulative treatment (such as grafting itself) which causes the hairs to be thrown off and replaced by new. We believe that this is because the primordia of new hairs are usually formed from the bases or shafts of the old follicles, to which the infective agent does not gain access (possibly because the rate of upward flow or migration of follicle epithelium is greater than the rate of spread of infection downwards). But black hairs *do* sometimes form in artificially blackened white epithelium; as often, it may be, as the primordia of new hairs are budded off from the blackened superficial epithelium rather than from the epithelium of effete follicles. (*c*) Contrary to the belief of Fessler[6], skin grafts, competently transplanted, invariably grow hairs. (*d*) The rate of blackening of a white-in-black graft seems to vary directly with the intrinsic (that is, 'graft-specific') rate of cell division in the epidermal graft. It is particularly high in sole-of-foot and claw-forming epithelia, and white grafts of such epithelia blacken in a matter of weeks. The rate of centripetal blackening of a white dorsal skin graft in a black skin area is, however, anomalously slow: we do not yet know why. (*e*) The pigmented character of artificially blackened epithelia of all types is a property of *all* the cells of their basal layers (cf. Fig. *B*). Whatever may be the role of melanophores in amphibian skin grafts, we have no evidence that they play any primary part in the phenomena we have described.

Summary. Black guinea pig epidermis has the power to 'infect' neighbouring white epidermis, and so to blacken it. This is shown not to be due to a cellular invasion and a replacement of white cells by black. It is due to an agent which, having entered white cells, brings about a permanent heritable change that causes them and their descendants to remain thereafter black. The infective agent may be a self-reproducing body housed normally in the cytoplasm; or, less probably, it may be a morphogenetic hormone that merely initiates the formation of such self-reproducing bodies in the white cells which it infects. The experiments described have a direct bearing on the problems of somatic cellular differentiation and heredity.

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FUNDAMENTAL PROBLEMS IN MODERN PHYSICS

THE Physical Society intends to hold a series of ordinary meetings at places outside London, and the first of these took place in the Physics Department of the University of Birmingham on December 20. This meeting, which took the form of a one-day conference under the general title "Fundamental Problems in Modern Physics", was attended by about two hundred fellows of the Society and visitors from universities, government establishments and industrial firms. The morning session was devoted to three papers; in the first, Prof. R. E. Peierls, of the University of Birmingham, discussed some of the outstanding difficulties of fundamental theoretical physics, and indicated the type of experimental evidence which would be most valuable in resolving them. He was followed by Mr. J. S. Gooden, also of the University of Birmingham, who read a paper on the design of a proton synchrotron, with special reference to the factors influencing the amplitude of phase oscillations of the particles and consequently affecting the intensity of the emergent beam. The third paper, by Mr. D. W. Fry, of the Telecommunications Research Establishment, dealt with some practical aspects of synchrotron design, in the light of experience gained with the three electron synchrotrons already under construction in Great Britain. A paper by Prof. J. Sayers, of the University of Birmingham, on recombination phenomena in highly ionized gases, opened the afternoon session; Prof. Sayers was unfortunately not able to be present at the meeting, but his paper was read by Prof. P. B. Moon. The conference closed with a paper by Dr. F. Hoyle, of Cambridge, on the synthesis of heavy elements from hydrogen in stars, and their distribution throughout space.

Prof. Peierls suggested three main lines of experimental investigation from which information useful to the theoretical physicist may be forthcoming. In the first of these, the energies of the nuclear particles involved are not excessive, and the greatest need is for improvement of measuring apparatus and for a systematic collection of results. In the case of β-disintegration, for example, it is now known that some of the apparent discrepancies between experiment and the original Fermi theory were due to experimental difficulties which have since been overcome; but there still remains some freedom of choice in formulating the theory, which can be narrowed down only by detailed knowledge of quantities such as the spin and symmetry of the initial and final nucleus and the distribution in energy of the emitted particles.

With regard to the short-range forces between particles in complex nuclei, Prof. Peierls pointed out that although Bohr's 'liquid drop' model represents the qualitative properties of such nuclei reasonably well, the assumptions made are independent of the nature of the forces involved, and hence the deductions drawn from them can give no information on this point.

Even if the laws of force were known, it would be impossible to calculate exactly the values of the energy-levels of complex nuclei, on account of the large number of particles involved. We must therefore discuss these nuclei in a statistical way, and so it becomes important to have a large amount of experimental data systematically collected. The

importance of each individual item might seem small, but that of the whole would be considerable if an effort were made to obtain as much information as possible about each energy-level, and great care were taken to proceed systematically in those cases where it is necessary to obtain information from transitions between two levels.

The difficulties with which the theoretical physicist has to contend in describing nuclear processes while still ignorant of the law of force between the particles are augmented by doubts as to the limits of applicability of the fundamental mechanical laws. For example, an unstable condition is predicted on extrapolating to short distances the law expressing the non-central force between the components of the deuteron. Experimental data on neutron–proton collisions, when the bombarding particle has a de Broglie wave-length of the same order of magnitude as the distance at which the simple law breaks down, would therefore be of value in suggesting suitable modifications for use at these distances. Particles with kinetic energy in the region of 12 MeV., or greater if possible, would be required, and accurate data from the scattering experiments are essential. Turning to experiments in which very high energies are required, Prof. Peierls pointed out that existing theory breaks down completely when applied to particles the distances of approach of which are of the order of 10^{-13} cm., and to states existing for the order of 10^{-23} sec. To provide a signpost for theory in this region, the study of collisions between elementary particles at energies of the order of 100 MeV. is necessary. Another possible outcome of experiments on particles with energies in the 100 MeV. region is the production of mesons in controllable experimental conditions, whereupon it might be possible to investigate their electric charge, to ascertain whether they have a range of masses, and to obtain further data on their spin, in circumstances more amenable to interpretation than those existing at present, when the only source of mesons is cosmic radiation.

In the two papers which followed, Mr. Gooden and Mr. Fry took up Prof. Peierls' challenge to practical physics by showing how high-energy particles might be obtained. Referring to the proton synchrotron under construction at the University of Birmingham, Mr. Gooden showed that in the case where the particle velocity, and consequently the frequency of the accelerating radio-frequency field, increases with increasing particle energy, some particles will possess a phase oscillation the amplitude of which is to a first approximation constant, and might, under certain conditions, steadily increase. If the amplitude is allowed to increase, these particles enter the region of unstable phase, and are lost from the circulating beam. Particles can, however, be accelerated provided that a careful control is exercised in the choice of those physical variables which affect the amplitude of the oscillation. Mr. Gooden showed that there are no less than eight significant forces affecting this oscillation, four of which cannot be varied. Three of these are associated with the radial displacement of a particle from the central, or stable, orbit, since such displacements determine the energy gain per revolution required to maintain the particle in its instantaneous orbit, the amount of magnetic flux enclosed by the orbit, and the response of the particle to changes in the frequency of the accelerating electric field. The fourth invariable force arises from the fact that, as the total kinetic energy of the particle increases, the radial displacement resulting from the given change in the energy-gain per revolution becomes smaller. The combined effect of these four forces is to produce a very small damping of the phase oscillation in the case of acceleration of protons to energies of about 1,000 MeV. The four variable forces were then discussed; these were shown to depend on the rate of change of the frequency and amplitude of the accelerating field, the form of time variation adopted for the magnetic field, and the shape of the faces of the accelerating chamber. Finally, Mr. Gooden considered the factors affecting the number of radio-frequency cycles, and the time interval per cycle, during which particles could be accepted for acceleration.

Mr. Fry restricted his attention to electron synchrotrons, and therefore discussed only those types of machine in which the initial acceleration (to velocities of about 0·98c) is obtained by betatron action, the radio-frequency accelerating pulse being phased to start just as the betatron core begins to become saturated. When the particle velocity is nearly equal to that of light, the orbital frequency will remain constant if the radius of the orbit is kept constant by suitable increase of the magnetic field with time; the frequency of the alternating voltage between the accelerating electrodes can then be constant during each pulse. After mentioning the essential components of a synchrotron system and the relative times at which the voltages must be applied to the injection gun, accelerating electrodes and ejection coils, Mr. Fry went on to describe the magnet systems used in the 30 MeV. machine designed by the Telecommunication Research Establishment and the 300 MeV. synchrotron which is being made by Metropolitan-Vickers with help from the Establishment for the University of Glasgow. To reduce the magnet weight, it is convenient to use a symmetrical iron circuit of high-quality laminations in which a high flux density can be achieved. Considerations of the maximum energy which has to be stored in the field show that it is desirable to keep the volume of the annulus in which the particles circulate as small as possible; this, in turn, necessitates very careful design and construction to prevent particles from being lost on account of irregularities or out-of-phase fields produced in air gaps by leakage from the magnet stampings. In the case of the 300 MeV. machine, the stored energy is supplied by a condenser bank; but the high cost of this equipment makes it necessary to consider alternative sources, such as a motor generator or a resonant magnet circuit working on a reduced duty cycle, to supply higher energy synchrotrons. Mr. Fry concluded his paper with a discussion of the type of resonator which it is proposed to use in the radio-frequency system, in order to minimize eddy current field, the technical problems associated with making the vacuum envelope for the 300 MeV. machine, and the arrangements for obtaining a high injection voltage (about 100 kV.) prior to betatron acceleration.

Prof. Sayers's paper began with a summary of the measurements by Kenty on the decay of ionization in argon after the sudden interruption of a low-voltage arc. Later measurements by Mohler in cæsium and mercury vapour were similar to Kenty's, in that mechanical commutators were used to interrupt the arc and apply voltages after various intervals to Langmuir probes, by which the electron densities were measured. Sayers used a cathode-ray oscilloscope to measure the current of a Langmuir probe, main-

tained at an adjustable potential, as a function of time after the interruption of a low-voltage arc in argon. From a series of such measurements the time-variation of the electron (or ion) concentration and the electron temperature could be determined at various places in the tube. The loss of particles by diffusion to the walls was illustrated by graphs showing the concentration as a function of position within the tube at different times; at first the concentration was practically uniform over the greater part of the tube, but this region of uniformity became more and more closely confined around the axis of the tube as time went on. Within this region, loss by diffusion may be neglected, so that the value of α, the coefficient of recombination, may be deduced from the equation $\frac{dN}{dt} = -\alpha N^2$, where N is the number per cubic centimetre of ions of either sign. Sayers found that α varies with electron temperature, but is independent of the pressure over the range 0·1–1·0 mm., as would be expected if the recombination is a two-body process. At an electron temperature of 1,000° K., α for argon is about $6{\cdot}6 \times 10^{-10}$ cm.^{3} sec.$^{-1}$.

In comparing these experiments with theory, Prof. Sayers pointed out that the probability of recombination to the ground state of the neutral atom is likely to be only a small fraction of the total recombination probability and, since the excited states will be roughly hydrogen-like for all atoms, it is not unreasonable to compare calculated values of α for oxygen with the experimental values obtained for argon, mercury and cæsium. The variation of α with electron temperature is as predicted by theory, but the absolute magnitude of α is about five hundred times larger than theory predicts. Observations on recombination in the F region of the ionosphere agree with the laboratory experiments, but considerations of the balance of electron population in interstellar space agree with the theoretical value. In contrast to these unresolved discrepancies concerning the capture of electrons into the whole series of states of the atom, measurements by optical methods of the radiative capture of electrons into individual atomic states seem to agree well with theory.

The discussion which followed centred largely around the question of whether, in the laboratory experiments, it is proper to consider the electrons as being in temperature equilibrium at each instant during the few milliseconds occupied by the decay of the ionization.

In the last paper of the afternoon session, Dr. Hoyle discussed one of the most fascinating problems of astrophysics—the process of synthesizing heavy elements from hydrogen and helium, and obtaining the observed distribution of these elements throughout space. There are two main problems to be considered: first, it is necessary to establish the conditions in which this synthesis can take place, and secondly to determine where, in the universe, these conditions are actually to be encountered. Having considered the very great difficulties involved in any theory which envisages conditions other than those of thermal equilibrium between the different elements, Dr. Hoyle proceeded to discuss the results obtained by applying statistical mechanics to the evolution of the heavy elements. He pointed out that from this point of view nuclear reactions can be treated by applying the well-known properties of statistical assemblies of dissociating gases, together with an equation determining the neutron-to-proton ratio as a function of density. This latter equation shows that both the concentration of free neutrons and the ratio of neutrons to protons increase with increasing density, and that to obtain a proportion of heavy elements in accordance with observation, densities of the order of 10^7 gm. per cm.^{3} are required. It can be shown also that to establish equilibrium between the various elements in a time sensibly less than the age of the universe, the region considered must have a temperature of the order of 10^9 degrees. The central temperatures of normal stars are too low by a factor of about 100, but in the case of those which have collapsed to a small fraction of their initial radius owing to the exhaustion of their hydrogen supply, temperatures of the required magnitude may be encountered. At some stage during the collapse, depending on the angular momentum, which differs widely from one star to another, the rotating spheroid becomes unstable, and material is thrown off into space from its equator. Now the nuclear reactions which would have to take place in order to re-establish equilibrium at the lower temperatures and densities require the emission of energy, so cooling is rapidly accelerated. Dr. Hoyle suggested that a small fraction of the heavy elements formed in a collapsed star remain 'frozen'. Thus, since the amount of material thrown off may amount to 99 per cent of the total mass of the star, such elements may be present both in the material thrown off and in the residual core. Dr. Hoyle connected the super-nova catastrophe with physical conditions inferred from the hypothesis that the Crab nebula represents the remains of a past super-nova.

Among difficulties raised in the course of the discussion was that of accounting for the presence of heavy elements in all known stars, which contain also hydrogen and helium.

THE GIACOBINID METEOR SHOWER, 1946

SEVERAL papers describing British observations of the Giacobinid meteor shower, 1946, were presented at a meeting of the Royal Astronomical Society on December 13, 1946. Special interest was attached to this subject because of the incidence of a shower of such exceptional intensity at a time when the considerable advances made by radar techniques were able to make an important contribution to the observations. Such methods not only enabled estimates of hourly rates to be made without interference due to poor visibility, but also demonstrated how information on certain meteor characteristics can be provided more conveniently and more precisely than is possible by visual meteor watches.

An introductory paper on the visual watch was given by J. P. M. Prentice, director of the Meteor Section of the British Astronomical Association. Although observations were considerably hindered by bad weather, it was possible to obtain a complete curve showing the variation in hourly rate by combining the results of several observers. The shower was of approximately six hours duration, rising steeply to a sharp maximum around 0345 hr., followed by a steep decline. The variation in rates was so rapid that the mean hourly rates, determined by averaging over short periods, are considerably affected by the length of period chosen. The visual observations were averaged over 7–8 minutes, and the maximum hourly rate corrected to a radiant in the

zenith was 2250. An allowance for the strong moonlight which prevailed was made by comparing the magnitude distribution with the corresponding distribution during the great shower of 1933, for which the observations of F. de Roy are available. Even when this factor is taken into account, the 1933 shower appeared to be at least twice as rich at all stages in the development as that of 1946. It had been anticipated that the shower would be richer in 1946 since the comet was so much nearer the earth at its node than in 1933, the distances being 135,000 miles in 1946 as compared with 500,000 miles in 1933.

Dr. A. C. B. Lovell then described the radar observations which he made with C. J. Banwell and J. A. Clegg at the University of Manchester. The aerial system, which was adjustable in both azimuth and elevation, provided a narrow radio beam at a wave-length of 4·2 m. An almost continuous watch was maintained for 71 hours between October 8 and 11. The radio echoes were generally recorded by visual observation of the cathode ray tube; but, in addition, a ciné-film was taken at 8 frames per second during the peak period.

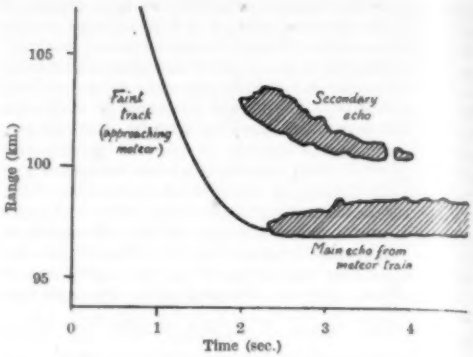
Throughout most of the watch the radio beam was directed at 90° from the Giacobinid radiant. To confirm that echoes are generally only obtained when the beam is perpendicular to the ionized trails produced by the passage of the meteors, the beam was directed towards the radiant for part of the shower, when it was found that the number of echoes fell to 4 per cent of the previous value.

Observations of the hourly rate of occurrence of echoes were made with the directional aerial system, supplemented by a dipole aerial system giving an almost all-round looking beam. Until 2100 hr. U.T. on October 9, the rate was very low, usually 2 per hour and never greater than 6 per hour. A very slight increase was recorded after 2100 hr. U.T.; but it was not until after 0000 hr. on October 10 that the shower suddenly developed. The maximum which occurred between 0340 to 0343 hr. U.T. was extremely sharp, and a peak rate of 168 echoes per minute, averaged over a period of 24 sec., was attained. Within ± 5 min. of this peak the rate was down to 50 per minute, and within ± 30 min. it was 1 per minute. By 0600 hr. the shower had passed completely.

An examination of the life histories of echoes recorded on the ciné-film showed, in a number of cases, very rapid fluctuations in amplitude with a fairly regular decay superimposed. An analysis of the distributions of heights, durations and amplitudes gave evidence of change during the progress of the shower, thus indicating either variation in the characteristics of the stream or in the conditions of the upper atmosphere. The ciné-film record obtained at the maximum of the shower provided a sufficiently accurate distribution of echo amplitude for an estimate to be made of the size distribution of the meteors by means of the theories of meteor ionization developed at the University of Manchester by Herlofson. It was shown that the number of electrons produced per cm. path by the meteor could be determined from the received echo strength, for a radio beam directed at right angles to the meteor train, from the relation

$$\text{received echo power} = 8{\cdot}88 \times 10^{-28} \frac{\alpha^2 \lambda^3}{R^3} P_0 G^2 \text{ watts},$$

where α is the number of electrons per cm. path, R the range of the echo in cm., λ the wave-length in cm., P_0 the peak transmitter power in watts, and



G the power gain of the aerial system (the same for transmitter and receiver) as compared with a half-wave dipole. Calculations by Herlofson showed that α is proportional to the size of the meteor and inversely proportional to the velocity. It was hence deduced from echo-strength measurements during the maximum of the Giacobinid shower that the number of meteors of a given size was inversely proportional to the size.

A visual watch was carried out simultaneously with the radar observation between 0014 and 0107 hr. U.T. and 0134 and 0228 hr. U.T., when the sky was clear; 26 per cent of the radio echoes observed during these periods were coincident with visual meteors. If the analysis is restricted to radio echoes of more than 0·5 sec. duration, then 50 per cent of these were coincident with visual meteors. This simultaneous watch afforded an opportunity of testing Herlofson's theory, according to which a meteor which produces 10^{10} electrons/cm. path will be at the limit of naked eye visibility. This value was found to be in general agreement with that deduced from calculations of the ionization necessary to give the observed radio echoes.

J. S. Hey gave an account of observations made in collaboration with S. J. Parsons and G. S. Stewart, at the Operational Research Group, Ministry of Supply. A continuous watch was maintained during October 7–11, with radar equipment of about 5 metres wave-length, using both visual and photographic recording of the cathode ray tube display. One of the most important results, which emerged as a consequence of improved photographic methods giving better resolution than hitherto, was the recording of the fine structure of the echoes and the determination of meteor velocity. The echoed signals were made to appear as bright spots on a linear-range trace on the cathode ray tube. This was photographed on a film moving at right angles to the trace at uniform speed. The resulting record thus gave a plot of echo-range against time. Satisfactory resolution was obtained by displaying a limited range-band of 80–115 km. over the full width of the cathode ray tube and by using a 35-mm. film moving at 2·4 mm. per sec.

In earlier work by Hey and Stewart (*Nature*, 158, 481; 1946), it was shown that the main echoes are obtained at right angles to the meteor trails. Some of the recordings in the present series showed clearly that prior to the formation of the main echo there is a faint fast-moving echo which can be associated with the ionization in the immediate vicinity of the

approaching meteor. Not until the ionized column approximately reaches the point of intersection of the normal from the observing station to the ionized column can the stronger and more enduring broadside echo be obtained. Secondary reflexions which appeared in the recordings can be attributed to the effects of drifts and diffusion which, as is known from visual meteor data, may cause irregularities in the train a few seconds after its formation. An example of a Giacobinid meteor echo, producing sufficient ionization around it for the track of the approaching meteor to be detected, is illustrated in the accompanying diagram, which is taken from a photographic recording.

These faint tracks resulting from the reflexion from the ionization in close proximity to the approaching meteor enabled the geocentric velocities to be determined without requiring a knowledge of the radiant position. The range–time characteristics, with few exceptions, were found to be representative of a body moving with uniform velocity in a straight line. The range R at any instant T is then given by

$$R^2 = R_0^2 + V^2 (T - T_0)^2,$$

where R_0 and T_0 represent the range and time when the range is a minimum and V is the geocentric velocity. From the analysis of twenty-two tracks, the weighted mean of the computed velocities was found to be 22·9 km./sec., with root-mean-square deviation of 1·3 km./sec., the weighting factor being made proportional to the duration of the track. This mean value is in close agreement with the theoretical velocity of 23·7 km./sec. given by Dr. J. G. Porter, director of the Computing Section of the British Astronomical Association.

Sir Edward Appleton and R. Naismith, who in 1932 noticed the general occurrence of the transient ionospheric radio (or radar) echoes which are now known to arise from the ionization trails of meteors, took part in the discussion. The results which they obtained on the occasion of the Giacobinid Shower of October 10 were described in these columns a few weeks ago (*Nature*, **158**, 936; 1946). Moreover, as a result of their systematic study of the diurnal and seasonal variations of both meteor ionization trails and sporadic ionization in the *E* layer of the ionosphere, they have been led to the important conclusion that the fine dust of sporadic meteors contributes substantially to the irregularities of ionization which have long been known to exist in the *E* layer. An account of these phenomena, and the descriptions of the investigations of the other radar workers mentioned above and of 60 Group R.A.F., are being given at a meeting of the Physical Society on January 31.

J. S. Hey

NEWS and VIEWS

Gold Medal of the Royal Astronomical Society: Prof. M. G. J. Minnaert

Prof. Marcel Gilles Jozef Minnaert, director of the Sonnenburg Observatory, Utrecht, has been awarded the Gold Medal of the Royal Astronomical Society for his outstanding contributions to solar physics and in particular to solar spectrophotometry. A pupil of Julius, he was later at Utrecht a colleague of Ornstein and Moll, and an early worker in the field of spectrophotometry, both developing the technique and applying it to a wide range of solar problems. He has taken part in a number of eclipse expeditions: to Sumatra in 1926 and 1929, and to Canada in 1932, all spoilt by clouds; his one successful expedition was to Lapland for the eclipse of 1927, where he obtained the first absolute values of the intensities of the chromospheric lines. He produced during the early days of the War a "Photometric Atlas of the Solar Spectrum", a most valuable contribution to solar spectroscopy. His later years in the War were spent in a concentration camp, from which he has emerged with his scientific enthusiasms undamped. He is chairman of the Commission on Spectrophotometry of the International Astronomical Union, a position for which he is well qualified by both experimental and theoretical studies. The distribution of energy in the sun's continuous spectrum and in that of the corona, the law of darkening of the sun's limb, and the polarization of the corona are among other subjects to which he has made valuable contributions. He has also worked on the direct photometry of Venus, the moon and red stars. His work is throughout characterized by a thoroughness, accuracy and care which have secured him a leading position in his own field. He was elected an associate of the Royal Astronomical Society in 1945.

Cadman Medal of the Institute of Petroleum: Mr. R. P. Russell

The Council of the Institute of Petroleum has awarded the Cadman Memorial Medal to Mr. Robert Price Russell, president of the Standard Oil Development Co., the central technical and research organisation of the Standard Oil Company (N.J.). Great services were rendered by Mr. Russell and his associates during the War in the production of high-octane aviation fuels, synthetic rubbers and toluene for explosives, and in the development of flame throwers, incendiaries and smoke generators. More than half the American output of aviation petrol for war-planes was manufactured by the catalytic cracking process, in which Mr. Russell played a notable part. Nine tenths of the American output of petroleum-based butadiene, the starting material in the manufacture of synthetic rubber, came from the process which Mr. Russell directed into large-scale production. In recognition of his war-time work, Mr. Russell was awarded the Medal for Merit, the highest civilian award in the United States. In 1946 he received the gold medal of the American Institute of Chemists for "noteworthy and outstanding service to the science of chemistry". Mr. Russell is well known personally in Great Britain, for he came here in 1944 as chairman of the Petroleum, Chemical and Rubber Division of the U.S. Strategic Bombing Survey. A team of scientific workers under his supervision entered Germany on the heels of the front-line troops to survey the enemy's vast oil-chemical industry.

Born in Massachusetts in 1898, Mr. Russell saw military service in the First World War; on resuming his studies, he obtained a master's degree in chemical engineering at the Massachusetts Institute of Technology in 1923. After holding some academic

appointments, he joined the Standard Oil Co. (N.J.), in 1927, when he became research director of the newly established Esso Laboratories at Baton Rouge, La. Here he initiated research on the hydrogenation process and the manufacture of synthetic products from petroleum. Mr. Russell is now directing research on new and improved uses for crude oil, the production of liquid fuels from coal and natural gas, and the development of improved synthetic rubbers and plastics.

Institution of Electrical Engineers: Honorary Member

THE Council of the Institution of Electrical Engineers has elected Sir John Macfarlane Kennedy, past president, to be an honorary member of the Institution, in recognition of his distinguished work in the sphere of electricity supply and of the services rendered by him to the Institution. Sir John was at Trinity College, Cambridge, and also went to Zurich Polytechnic. He served his pupillage with Richard Moreland and Sons, London, Willans and Robinson, Rugby, and Siemens-Halske, Berlin. During 1902–34 he was a partner in the firm of Kennedy and Donkin, and was engaged in electricity supply, distribution and traction works. In 1922 he submitted to the Electricity Commissioners proposals for the reorganisation of electricity supply in Great Britain, and eventually prepared a report for the Ministry of Transport on the reorganisation of electricity supply. In 1934 he took office with the Electricity Commission, of which he is now deputy-chairman.

Faraday Medal

THE Faraday Medal of the Institution has been awarded to Sir Standen Leonard Pearce, for his outstanding contributions to the advancement of engineering practice and notable achievements in electrical engineering. Sir Leonard Pearce was educated at Bishops Stortford College and Finsbury Technical College, London. He served his pupillage with J. G. Statter and Co. at West Drayton, and Thomas Richardson and Sons of Hartlepool. After occupying various posts, he was appointed in 1903 to be chief engineer to Manchester Corporation Electricity Undertaking; in 1926 he became engineer-in-chief of the London Power Co.

Prof. F. J. W. Roughton, F.R.S.

DR. F. J. W. ROUGHTON, who succeeds Prof. E. K. Rideal in the John Humphrey Plummer professorship of colloid science in the University of Cambridge, is a physiologist admirably qualified to deal with the border-line between biological and physical science. Since his election to a fellowship at Trinity College, Cambridge, in 1923, his researches have been concerned with the carriage of gases by the blood and with the physical chemistry of the blood pigments. His best-known work is that begun with Meldrum on the enzyme carbonic anhydrase, which plays an important part in the transport of carbon dioxide from the tissues to the lungs. Physical chemists will remember also the ingenious methods which he used with Hartridge to study the rapid rate of combination of oxygen with hæmoglobin. Largely as the result of his work, the complex interchanges between the corpuscles and the plasma in the lung capillaries are far more clearly understood. His wide knowledge of physico-chemical techniques and of their application to biological problems has made him an authority in a field which is rapidly becoming one of the growing points in natural science; and physiologists will wish him every success in an appointment which will give full scope to his talent for reducing biological equations to measurable terms.

Human Nutrition at the London School of Hygiene and Tropical Medicine: Prof. B. S. Platt, C.M.G.

THE increasing importance attached to the scientific study of nutrition is reflected in the appointment of Dr. B. S. Platt as professor of human nutrition at the London School of Hygiene and Tropical Medicine. Dr. Platt will continue to hold, in conjunction with the chair, his present post as director of the Medical Research Council's Research Unit of Human Nutrition, at the National Hospital, Queen Square, London. His appointment is thus also another welcome sign of the growing readiness of universities to elect to professorial rank those whose duties are primarily in research; under the old system a professor was too often so fully occupied with teaching as to have little time left for research. Dr. Platt graduated in the School of Chemistry at Leeds in 1923. He engaged in research there under the late Prof. J. B. Cohen, was elected to a Beit Memorial Fellowship in 1926, and became medically qualified in 1930. During 1932–38 he was attached to the Division of Clinical Research of the Henry Lester Institute of Medical Research at Shanghai, as associate in medicine, and in 1932 was the author of the B.M.A. "Bishop Harman Prize Essay" on "The Importance of Vitamin B_1 for Maternal Health in Pregnancy and Lactation". In 1938 he was appointed to the scientific staff of the Medical Research Council, and since 1944 has been director of the Council's Human Nutrition Research Unit.

Dr. Platt has served as a nutritional expert on a considerable number of government committees, including the Scientific Food Policy Committee, the Committee for the Care of Shipwrecked Personnel, the Rations Sub-committee of the Military Personnel Research Committee, and the United Kingdom Delegation to the Food and Agriculture Organisation Conferences; and in his work he has travelled widely, including visits to West and East African territories, Newfoundland and the West Indies. In 1944, he gave the De Lamar Lecture in hygiene at the Johns Hopkins University. He has published a considerable number of papers, dealing mostly with biochemical studies on water-soluble vitamins, his best known work perhaps being that with Miss Lu on the blood pyruvate in vitamin B_1 deficiency in man.

Prof. Frank Horton, F.R.S.

THE recent retirement of Prof. Frank Horton from the University chair of physics which he has held at the Royal Holloway College (University of London) since 1914 brings to an end an active teaching career lasting more than forty years. That career really falls into two parts, Cambridge and London, though it should be mentioned that he received his earlier training at Birmingham, of which University he holds the degree of M.Sc. At Cambridge, as a lecturer at the Cavendish Laboratory in the days of J. J. Thomson, he formed one of that brilliant team of young physicists comparable in their way with those other teams in other spheres during the same epoch, namely, 'Cromer's young men' in Egypt and the Sudan, and 'Milner's young men' in South Africa. An early

election to a fellowship of the Royal Society placed a hallmark on the value of his contributions to the field of science in which he specialized.

Prof. Horton went to London in 1914. There, in addition to his teaching and research work, he soon entered into the inner circles of university administration, culminating in 1939 with his election as vice-chancellor. He continued to hold this high and arduous office throughout the War. To quote the words used by the principal of the University in his latest report: "No period of its history was more fraught with danger for the University than these six years, danger not only of physical destruction but of spiritual disintegration. Under the emergency measures which were taken to carry on the work of the University, the Vice-Chancellor was entrusted with wide powers. They were used with the utmost discretion and judgment. Professor Horton enjoyed none of the pomp and pageantry which fall to the lot of the Vice-Chancellor in normal times, but he must surely feel that the widespread and sincere tributes paid to his exceptional services afford some measure of compensation." The Senate, realizing that his term of office as a faculty representative was drawing to a close, paid tribute to the debt which it owed to his services by electing him as one of its co-opted members.

National Institute of Sciences of India: Elections

THE following have been elected ordinary fellows of the National Institute of Sciences of India: Mr. S. Basu, deputy director general (forecasting), Poona, distinguished for his work in weather forecasting; Dr. U. P. Basu, chief chemist, Bengal Immunity Co., Ltd., Calcutta, distinguished for his work in chemotherapy; Mr. J. Coates, senior geologist, Burmah Oil Co., Ltd., Digboi, distinguished for his work in geology; Dr. G. Krishnamurti, assistant director, Department of Chemotherapy, Haffkine Institute, Bombay, distinguished for his work on Indian medicinal plants; Dr. B. S. Kadam, Central Tobacco Research Station, Guntur, distinguished for his work in genetics and plant breeding; Prof. D. D. Kosambi, professor of mathematics, Tata Institute of Fundamental Research, Bombay, distinguished for his work in path geometry and statistics; Mr. V. Khanolkar, director of laboratories, Tata Memorial Hospital, Bombay, distinguished for his work in human pathology; Dr. D. R. Malhotra, B.B. and C.I. Railway, Ajmer, distinguished for his work in metallurgical chemistry; Dr. B. Mundkur, mycologist, Imperial Agricultural Research Institute, New Delhi, distinguished for his work in systematic mycology; Dr. B. Narayana, professor of physiology, Prince of Wales Medical College, Patna, distinguished for his work in physiology; Dr. B. P. Pal, economic botanist, Imperial Agricultural Research Institute, New Delhi, distinguished for his work in genetics and plant breeding; Dr. V. G. Panse, statistician, Institute of Plant Industry, Indore, distinguished for his work on the application of statistical methods of plant breeding; Dr. P. B. Sarkar, senior research chemist, Indian Central Jute Committee, Calcutta, distinguished for his work on the chemistry of jute; Dr. B. N. Srivastava, Physics Department, University of Allahabad, distinguished for his work in thermodynamics; Dr. L. C. Verman, director of physical laboratories, Council for Scientific and Industrial Research, Delhi, distinguished for his work in applied physics.

Geological Society Awards

THE Council of the Geological Society announces the following awards:

Wollaston Medal to Dr. Joseph Burr Tyrrell, for his services to geological science in the Dominion of Canada, more particularly his pioneer work on the Barren Lands west of Hudson Bay and on the goldfields of Klondyke and Kirkland Lake.

Murchison Medal to Mr. Percy Evans, in recognition of his researches on the oilfields of Burma and Assam, and his work on the geological interpretation of gravitational surveys.

Lyell Medal to Dr. Stanley Smith, for his researches on Palæozoic corals, particularly their structure and relationships, and for his investigations into Lower Palæozoic and Carboniferous stratigraphy.

Bigsby Medal to Dr. George Hoole Mitchell, for his geological investigations in the Lake District and his work on the coalfields of Yorkshire and the Midlands.

Wollaston Fund to Dr. Austin William Woodland, for his work on the Cambrian rocks of Merionethshire and on the water supply of the Midlands and East Anglia.

Murchison Fund to Dr. Duncan Leitch, in recognition of his studies of the Carboniferous stratigraphy of Scotland and his investigations of the lamellibranch faunas of the Scottish coalfields.

A moiety of the Lyell Fund to Dr. Leslie Rowsell Moore, for his investigations of Upper Carboniferous faunas and floras of the Bristol, Somerset and South Wales coalfields; another moiety of the Lyell Fund to Mr. Claude William Wright, for his work on the faunas of the Cretaceous rocks of southern England and the Yorkshire and Lincolnshire wolds.

Physical Society's Proposed Acoustics Group

A MEETING of those interested in the formation of an Acoustics Group of the Physical Society will be held in the Jarvis Hall of the Royal Institute of British Architects, 66 Portland Place, London, W.1, at 3 p.m. on February 19. Mr. H. L. Kirke, head of the B.B.C. Research Department, will be in the chair, and Dr. Alex Wood will give an address on "The Contribution of Acoustical Science to Allied Studies". It is hoped to arrange an informal exhibition of recent acoustical apparatus. The agenda for the meeting will include a general discussion of the proposal to form such a group, the election of a chairman and officers, and the adoption of a set of rules. Those interested should send their names, indicating whether they will be able to attend the meeting, to the acting secretaries, Mr. A. T. Pickles and Mr. W. A. Allen, at the office of the Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

Recenti Progressi in Medicina

THE appearance of the first issue (dated October 1946) of *Recenti Progressi in Medicina*, a monthly review of international medical and surgical literature, published in Rome under the directorship of Giuseppe Lazzaro, supported by some twenty-eight collaborators, is an interesting development of post-war medical activity in Italy. This first issue, which owes much to the advice and experience of Prof. Giuseppe Bastianelli, to whom the editor pays a warm tribute, is mainly devoted to a review of recent progress in our knowledge of the various types of inflammation of the lungs. It deals not only with the types of pneumonia caused by bacteria, but also with in-

fluenzal pneumonia, coccidiomycosis, *Q*-fever and psittacosis. An especially long and detailed section, illustrated by X-ray photographs, deals with primary atypical pneumonia. Another article is devoted to the condition known to some as infiltration of Hegglen or pneumonia associated with a positive Wassermann reaction. Treatment of the pneumonias with penicillin and sulphonamides is the subject of another article, and there are abstracts from literature dealing with other aspects of the study of inflammation of the lungs. A short section records two immunological laboratory procedures. A bibliographical section consists entirely of the contents of the *British Medical Journal* during the months January to April 1946.

The next issue of this journal will be devoted to recent progress in the treatment of disease with penicillin, and will contain articles by Sir Alexander Fleming and Sir Howard Florey, the translation of these two articles having been aided by the British Council. The editors offer a special word of thanks to the British Council and to the president of the Medical Section of American Relief in Italy for the help given to them in the publication of the journal. British and American sources predominate in the first issue. Future numbers will be awaited with interest. The journal should do much, not only to bring Italian medical men the latest information on a wide variety of subjects, but also to promote co-operation between them and medical men in other countries.

Trees Used for Animal Fodder in India

INDIAN FOREST LEAFLET No. 82 (Sylviculture) (Forest Research Institute, Dehra Dun. Pp. iv+17. 8 an.) discusses those trees the foliage of which is used for animal fodder in India. It is the third edition of a small publication written by M. V. Laurie, then sylviculturist at the Forest Research Institute, Dehra Dun, first issued in 1939. It was quickly sold out, as also was the second edition, the present being a revised third edition. India has been one of the countries the population of which has been much addicted to tree lopping, usually to provide forage for animals. With the appearance of the Animal Husbandry Wing of the Agricultural Research Council in India, a start was made in collecting information on the subject of fodder grasses and general fodder supplies. It was left to the Forest Research Institute at Dehra Dun to institute inquiries into the trees used for this purpose—and used very often to the detriment of the forests so maltreated. The list does not make any claim to scientific accuracy, but merely represents the consolidated opinions of forest officers throughout India of the relative popularity of different trees for lopping for fodder.

British Council Scholarships, 1946–47

FOR the current academic year, 248 graduates and others of like status from overseas have been awarded British Council scholarships, which enable them to take a wide range of post-graduate courses of study in British universities and similar institutions. The scholarships are normally for one year, but extensions are granted in suitable cases. In addition, the Council has helped to place many students who have come to Britain under the auspices of overseas authorities or privately. The Council has this year established a Students' Welfare Department to deal with the reception and non-academic welfare of scholarship holders, and to help them to gain a general knowledge of British life and institutions. To this end vacation courses, which enable those residing in London to visit the provinces and vice-versa, as well as term-time talks, discussions, shows of documentary films and other events are arranged. These facilities are available also to students sponsored by the Colonial Office, the Indian and Sudan Governments, and to other overseas students. Scholarship holders this year have come from some fifty Empire and foreign countries. The awards are for various subjects, including agriculture and agricultural sciences (6), engineering and mining (15), sciences and technology (50).

Spectrochimica Acta

AN international medium for the publication of research results in applied spectroscopy was launched in 1939, and published by Julius Springer in Berlin until 1944. This is being revived under the joint editorship of several spectroscopists, as before. The editorial board will consist of: Dr. A. Gatterer (Vatican Observatory), Mr. E. van Someren (London), Prof. R. Breckpot (Louvain), Dr. W. Gerlach (Munich), Dr. H. Kaiser (Jena) and Dr. L. W. Strock (Saratoga Springs). The first number of the third volume should appear early in 1947, and authors of papers on emission or absorption spectroscopy are invited to submit manuscripts, in English, French, German or Italian, to the nearest member of the editorial board. Publication should be fairly prompt, by current standards. As in most scientific publications, authors are urged to be concise; but the paper supplies are sufficient to allow each author 75 reprints. The printing will be undertaken by the printers in the Vatican City, who are accustomed to dealing with a variety of languages. Authors in Great Britain should communicate with Mr. E. van Someren, 20 Churchfields, Broxbourne, Herts.

Announcements

THE Medical Research Council has appointed Dr. S. T. Cowan (formerly of the University of Manchester) to succeed Dr. R. St. John Brooks as director of the National Collection of Type Cultures of Micro-organisms. The Collection continues to be housed at the Elstree establishment of the Lister Institute of Preventive Medicine, but will be moved to the Central Public Health Laboratory at Colindale as soon as accommodation there is available.

MR. J. B. BENNETT has been appointed to succeed the late Mr. W. Barnicot as secretary of Rothamsted Experimental Station.

IN accordance with its usual practice, Trinity College, Cambridge, announces the offer of a research studentship open to graduates of other universities who propose to go to Cambridge in October next as candidates for the degree of Ph.D. The value of the studentship may be as much as £300 a year. Candidates must not have reached the age of twenty-six before May 1 (length of war service can be added). The College also offers, as usual, exhibitions of the value of £40 to students of Dominion and Colonial universities who wish to go to Cambridge next October as candidates for the degree of B.A., M.Litt., M.Sc., or Ph.D. A candidate for a studentship or exhibition should apply through the principal authority of his university, and his application must reach the Senior Tutor, Trinity College, Cambridge (from whom further particulars may be obtained), by May 1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Ethical Aspects of the Development of Atomic Energy

WHEN I read the editorial article in *Nature* of December 21 on "Ethical Aspects of the Development of Atomic Energy" I had not seen "Programme for Survival" by Prof. Lewis Mumford, reviewed in that article. I have now obtained and read it—with surprise; for you say "Unconditional co-operation, Prof. Mumford holds, *is* the price of mankind's survival; and he sets that as the objective, urgent and imperative, but not to be attained unilaterally or forthwith as Mr. Lionel Curtis is inclined to suggest". Yet on p. 4, Prof. Mumford writes, "We must think swiftly, plan swiftly, act swiftly". I am all the more puzzled because the article in *Nature* had noted that "Prof. Mumford is as insistent as scientific men themselves that we have only a limited time in which to learn the art of control and to prevent the suicidal misuse of scientific knowledge".

Reference is made to the report of scientific men transmitted on June 11, 1945, to the Secretary of War at Washington, and they are reported as urging that "the political problems arising from the mastering of nuclear power should be recognized in all their gravity, and that appropriate steps should be taken for their study and for the preparation of the necessary decisions. The existence of nuclear weapons is regarded as the most compelling argument calling for an efficient international organisation for peace."

The date of this report is significant. Before the atomic bombs had been dropped on Japan its inventors had realized the need to establish an international organisation powerful enough to control their terrible weapon and were warning their political chief in advance. They, at any rate, did not regard advice to postpone the creation of such an authority as a counsel of wisdom.

It is rightly said that Prof. Mumford wants the world "to wait a decade if need be before the harnessing of atomic energy to peaceful purposes proceeds apace".

But soldiers, industrialists and rulers are not going to wait because we wish them to wait. The *Nature* article continues: "The future of humanity depends, as Prof. Mumford asserts, on the three great Powers, not less than others, placing themselves strictly under the judgment and the surveillance of the rest of the world. . . . 'The authority of the United Nations must be unqualified and universal; every last laboratory and factory must be open to investigation by authorized international agents, responsible to the central world authority. The power to spread, limit or even outlaw scientific investigation must reside in such a body no less than the power to outlaw completely all national armies. Privacy, secrecy, sovereignty must be unconditionally surrendered to a common body whose prescribed powers must override all local administrative organs at every point that is necessary to ensure freedom from fear and freedom from unlawful aggression.'"

To all this no one could agree more fervently than I. But things like this are not to be done by mere wishing or by words, however eloquent. They can only be done, to quote the *Nature* article, by bringing "the fact-finding method of science into the political sphere as a step towards the elucidation of policy 'and measures'", or in the words of the report of the scientific men quoted above: "the political problems arising from the mastering of nuclear power should be recognized in all their gravity, and appropriate steps should be taken for their study and for the preparation of the necessary decisions".

I quote this last passage because this exactly was done by the Leave Groups of men and women of all ranks from the Forces of all the United Nations who met every week in Balliol College, Oxford, for the last three years of the War. Some three thousand passed through these groups all inspired by the purpose of working out some plan for an international democracy strong enough to save their children from a third World War, from such horrors as they were facing in the Second World War and their fathers had faced in the First. It was my privilege to lead their discussions. The results hammered out week by week are fully stated in "World War; its Cause and Cure", and more shortly in "War or Peace?". I think Prof. Mumford would take heart if he studied these records and realized how far effect had already been given to methods advocated in the American report you quote, and also in your own article. These results are now known as the Leave Groups policy, a policy in the real sense of the word. But a policy, however carefully framed, is not by itself enough. I think Prof. Mumford sees this when he says "It is a question of dynamic will-power", though I prefer the simpler words "of leadership", such leadership as Mr. Winston Churchill gave us in 1940 and throughout the War. Field-Marshal Smuts saw this in his great speech at The Hague—when he called on Britain to lead the democracies, impotent as they now are, to strength and the safety that strength alone can give. My own comment on this was that a nation can lead other nations only in so far as it is itself led by one of its own recognized leaders.

Since the *Nature* article appeared on December 21, Mr. Winston Churchill has published his two momentous articles in the *Daily Telegraph* of December 30 and 31 entitled "The Way to Stop a New War". His thought seems to have led him to the same conclusions as those reached in the Leave Groups after three years of discussion. Let me quote his significant words. "One spasm of resolve! One single gesture! The prison doors clang open. Out walk, or totter, the captives into the sunshine of a joyous world. I do not at all conceal from the reader that an act of the Sublime is required. It is a very simple act, not even a forward bound. Just stand erect, but all together. . . . If we cannot get all countries, we must get all we can; and there may be many. . . . It may well be that everybody cannot join the club at once. The beginning must be made. The nucleus must be formed in relation to the structure as a whole, so that others can join easily as soon as they feel inclined or feel able. The ideal is so commanding that it can afford a gradual realisation.

"Of all the deterrents against war now acting upon the minds of men, nothing is comparable to this frightful agency of indiscriminate destruction. While this supreme weapon rests in the hands of the United States alone, it is probable, though we cannot say it is certain, that a breathing space will be accorded to the world. We cannot tell how long this breathing space will last. Let us make sure that it is not cast away. If, in this interval we can revive the life and unity of Europe and Christendom,

and with this new reinforcement build high and commanding a world structure of peace which no one dare challenge, the most awful crisis of history will have passed away and the high road of the future will again become open. . . . If during the next five years we can build a world structure of irresistible force and inviolable authority, there are no limits to the blessings which all men may enjoy and share."

Mr. Churchill makes it clear that in our own country this must be the work of both parties, for he tells us that "Mr. Attlee has declared 'Europe must federate or perish' and he does not readily change his opinions".

So since the *Nature* article was published the leadership to action which we needed and for which we have waited so long has been given.

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Jan. 13.

Nuclear Disintegration by Meson Capture

RECENTLY, multiple nuclear disintegration 'stars', produced by cosmic radiation, have been investigated by the photographic emulsion technique. Plates coated with 50 μ Ilford B.1 emulsions[1] were exposed in aircraft for several hours at 30,000 ft. One of these disintegrations was of particular interest, for whereas all stars previously observed had been initiated by radiation not producing ionizing tracks in the emulsion, the one in question appears to be due to nuclear capture of a charged particle, presumably a slow meson.

The star consists of four tracks *A*, *B*, *C* and *D* (Fig. 1). *A*, *B* and *D* lie almost in the plane of the emulsion, whereas *C* dips steeply (at about 40°) and ends in the glass. *D* is due to a proton of energy 3·7 MeV., and *C* also corresponds to a proton, of more than 3 MeV., and most likely about 5 MeV. Track *B* was most probably produced by a triton of 5·6 MeV. A short track, about 1 μ long, between *A* and *B* is apparently due to the residual recoil nucleus.

Track *A* appears to enter the emulsion surface about 150 μ from the star centre. On account of the relatively large distances between consecutive grains at this range, the track cannot be distinguished at all easily against the spontaneous background of grains, and only the last 100 μ of track (below arrow) can be traced with certainty. Assuming it to be singly charged, the mass of the particle producing track *A* has been roughly evaluated by the following methods.

(1) Both ionization and scattering increase towards the origin of the star, hence the particle was definitely travelling *towards* the disintegration point.

An electron is discounted because the observed ionization is far too high (an electron track of this range would, in fact, not be detected at all), and the scattering too small. On the other hand, a proton is discounted since the observed scattering is too great (Fig. 2). We must, therefore, conclude that the particle had a mass intermediate between that of electron and proton.

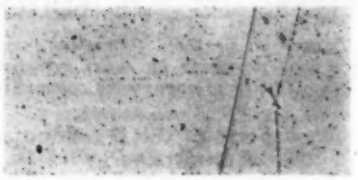


Fig. 1 *a*. PHOTOMICROGRAPH OF CENTRE OF STAR, SHOWING TRACK OF MESON PRODUCING DISINTEGRATION. (LEITZ 2 MM. OIL-IMMERSION OBJECTIVE. × 500)

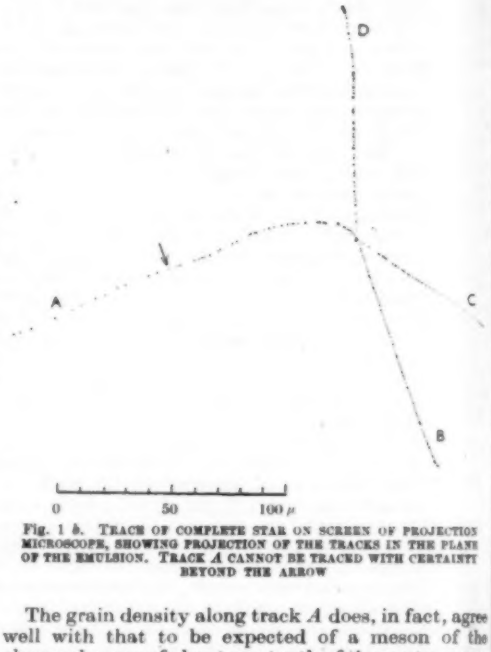
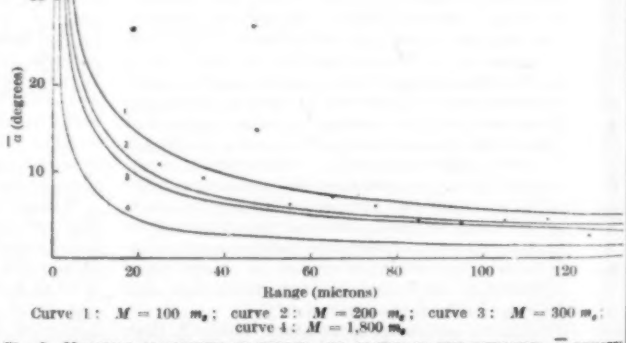


Fig. 1 *b*. TRACE OF COMPLETE STAR ON SCREEN OF PROJECTION MICROSCOPE, SHOWING PROJECTION OF THE TRACKS IN THE PLANE OF THE EMULSION. TRACK *A* CANNOT BE TRACED WITH CERTAINTY BEYOND THE ARROW

The grain density along track *A* does, in fact, agree well with that to be expected of a meson of the observed range of about one tenth of the proton mass. The range-energy curve for mesons in the emulsion has been obtained from that for protons (kindly lent by Dr. C. F. Powell), using the ratio of the masses of the two particles.



Curve 1: $M = 100\ m_e$; curve 2: $M = 200\ m_e$; curve 3: $M = 300\ m_e$; curve 4: $M = 1{,}800\ m_e$

Fig. 2. MULTIPLE SCATTERING OF MESONS AND PROTON IN THE EMULSION. $\bar{\alpha}$ DENOTES THE MEAN ANGLE OF SCATTERING FOR A 10 μ LAYER OF THE EMULSION. CURVES CALCULATED FOR PARTICLES OF MASS 100 m_e, 200 m_e, 300 m_e AND 1,800 m_e (PROTON), m_e BEING THE ELECTRON MASS. EXPERIMENTAL POINTS, FROM MEASUREMENTS ON TRACK *A*, INDICATED BY DOTS

(2) The elastic scattering of mesons and protons can be calculated from the known emulsion constitution, using Williams's formula[2] for the mean square angle of multiple scattering, and is shown plotted against range in Fig. 2. Bearing in mind the fact that the single scattering will introduce large fluctuations, the experimental points appear to be consistent with a meson mass between 100 m_e and 300 m_e, m_e being the electron mass. Only the horizontal projection of the scattering along the track can actually be measured; on the average, multiplying this by a factor $\sqrt{2}$ will give the true value. The scattering of fast electrons cannot be found from any simple formula, but it is certainly much greater than the observed values.

(3) A value of the meson mass can also be arrived at from the energy required in the nuclear disintegration. In this process, the emitted particles must have sufficient energy to surmount the potential barrier, so that the disintegrating nucleus in this case cannot be that of silver or bromine, and must, therefore, be either carbon, oxygen or nitrogen (in the gelatin).

An approximate calculation of the momentum of the recoil nucleus indicates that at least one neutron must be postulated to conserve momentum; the kinetic energy of this neutron must be around 4 MeV. If we assume that a negative meson is captured by a nucleus nearly at the end of its range and is annihilated, so that the rest energy of the meson becomes nuclear excitation energy, we could have disintegration schemes such as

$$Y^- + O^{16}_8 \rightarrow N^{16*}_7 \rightarrow H^3_1 + 2H^1_1 + n^1_0 + Be^{10*}_4 \quad (\text{or } 2n^1_0 + Be^9_4)$$

$$Y^- + N^{14}_7 \rightarrow C^{14*}_6 \rightarrow H^3_1 + 2H^1_1 + n^1_0 + Li^{6*}_3$$

$$Y^- + C^{12}_6 \rightarrow B^{10*}_5 \rightarrow H^3_1 + 2H^1_1 + n^1_0 + He^{6*}_2$$

As the recoil nucleus would be expected to have a fairly high excitation energy (5–10 MeV.) above the ground-state, it must be relatively stable against further disintegration into charged particles. With this limitation, there are still a large number of possible reactions (considering all isotopes of carbon, oxygen and nitrogen), but it appears that in general the mass excess of the recoil nucleus $\sim$ 15 MeV., whereas that of the initial one $\sim$ 5 MeV. or less. The negative Q value of the reaction, allowing for excitation energy, is then found to be $\sim$ 60 MeV., and the total kinetic energy of the ejected particles $\sim$ 20 MeV. The total excitation energy of the original nucleus would then be $\sim$ 80 MeV., probably with an error of $\pm$ 20 MeV. (to allow for the various numbers of neutrons emitted, etc.).

On the above hypothesis, the meson should, therefore, have a rest energy of 60–100 MeV., that is, a mass of between 120 m_e and 200 m_e.

Near the end of the meson track, a small number of grains are observed slightly off the main track. If these are due to fast secondary electrons, their ranges appear to be considerably greater than would be expected from the energy of the primary.

I am indebted to the A.O.C., Royal Air Force, Benson, Oxon., for kindly exposing the plates.

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Jan. 8.

[2] Powell, Occhialini, Livesey and Chilton, *J. Sci. Instr.*, **23**, 102 (1946).
[3] Williams, *Proc. Roy. Soc.*, A, **169**, 531 (1938).

Angular Distribution of Protons Ejected in the Disintegration of Nitrogen by α-Particles

Using a powerful polonium source and an especially well-defined geometry, we have recently obtained 850 expansion-chamber photographs showing 90 proton tracks produced on the disintegration of nitrogen by α-particle bombardment. Our arrangement, therefore, gave on the average one disintegration for every ten photographs, thus greatly reducing both the expense of the photographic materials used and the labour of the examination of the photographs.

The number of disintegrations decreases rapidly as the energy of the α-particles is reduced, but the photographs show that disintegrations occur quite definitely for energies less than 1·7 MeV., and probably at energies less than 1 MeV.

The angular distribution shows a marked change with energy. For α-particles of energy less than 3 MeV., the distribution is almost uniform in numbers between 30° and 120°, while at 3·5 MeV. there is a marked preponderance at about 90° with proportionately smaller numbers of protons ejected symmetrically at angles greater and less than this value. It is interesting to recall that the well-known disintegrations recorded by Blackett and Lees[1] for 3–4 MeV. α-particles in nitrogen both show the ejection of the proton in the neighbourhood of 90°.

A full report of the experiment, together with selected photographs, will be published elsewhere.

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Dec. 10.

[1] Blackett, P. M. S., and Lees, D. S., *Proc. Roy. Soc.*, A, **136**, 325 (1932).

A Revised Estimate of the Age of the Earth

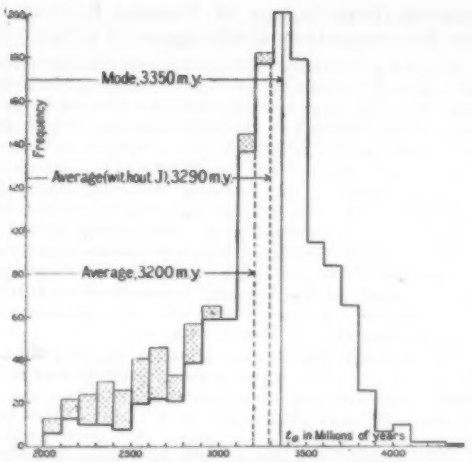
Since the publication of my preliminary account of a new method of estimating the age of the earth[1], based on Nier's isotopic analyses of samples of lead from galena and other lead minerals of known geological age, I have revised the calculations, using Glaisher's Exponential Tables[2], and greatly increased the number of solutions. 1,419 solutions for t_0 (the time since the isotopic constitution of the earth's primeval lead began to be modified by additions of lead isotopes generated from uranium I, actinium U and thorium) and for x and y (the respective isotopic abundances of Pb^{206} and Pb^{207} in primeval lead) have been obtained from the following combinations of data (Table 1). The numbers are those of the lead samples as listed in the original article[1], and the italicized figures in brackets are the approximate ages in millions of years (t_m) of the parental lead minerals.

Table 1

Number of lead sample	Combined with Nos.	and also with Nos.
25 (Great Bear Lake, *1330*)	1, 2, 3, 5, 6 (*25*)	19 and 21
23 (Broken Hill, N.S.W., *1200*)	7 (*60*)	19 and 21
22 (Broken Hill, N.S.W., *1200*)	9 and 11	19 and 21
21 (Quebec, *800*)	(Joplin, *100*)	19
19 (Ivigtut, *600*)	13–18 (*220*)	—

together with combinations of each of the above five sets with the others.

The data for six samples have not been used: either because the ages of the parent minerals are unknown or because the constitutions of the leads are so abnormal as to give highly discordant and mutually divergent results.



HISTOGRAM REPRESENTING THE FREQUENCY DISTRIBUTION OF 1,419 SOLUTIONS FOR t_0 WITHIN RANGES OF 100 M.Y. THE FREQUENCIES OF 162 SOLUTIONS (J) INVOLVING THE JOPLIN LEADS, NOS. 9 AND 11, ARE INDICATED BY DOTTING. THE HISTOGRAM FOR 1,257 SOLUTIONS (WITHOUT J) IS INDICATED BY BOLD LINES

As shown by the accompanying histogram, the solutions for t_0 now range from 2,000 to more than 4,000 m.y., but have a marked concentration around 3,350 m.y. A few additional results fall below 2,000 m.y., but as these are inconsistent with the ages of the oldest known rocks, and give impossibly high values for x and y, they have been neglected. The relatively narrow range of the solutions for t_0 originally published[1] (2,700–3,150 m.y.) was due, partly to the limited number of solutions then completed, partly to an early work-sheet error in copying Nier's figure for the isotopic abundance of Pb^{206} in the Joplin lead No. 11. This mistake did not affect the estimate of t_0 which was finally adopted, but it made it appear that the solutions involving the Joplin data were in far better agreement with those not involving the Joplin data than they actually are.

It is now clear, as originally suspected, that the Joplin samples of lead are all of abnormal isotopic constitution. The solutions involving Joplin data are indicated separately in the histogram, in order to bring out the facts (*a*) that they all lie on the left-hand side of the frequency maximum or mode; (*b*) that the histogram becomes much less skew without them; and (*c*) that the mode itself is independent of the Joplin solutions.

The new average and modal solutions, together with the original one, are listed in Table 2.

TABLE 2

	Original solution (Holmes, 1946[1])	Average of 1419 solutions (including J*)	Average of 1257 solutions (excluding J*)	Modal solution (see Fig.)
Age of earth (in m.y.) t_0	3000	3200	3290	3350
Primeval lead ($Pb^{204} = 1$)				
x (Pb^{206})	12·50	11·20	11·04	10·945
y (Pb^{207})	14·28	13·70	13·61	13·51
Sum of squares of 'age anomalies' (see Table 3)	686,500	138,125	66,725	58,900
Sum of squares (including J* anomalies)	933,000	281,775	270,375	265,475

* 'J' refers to solutions involving the Joplin leads Nos. 9 and 11.

TABLE 3

Test of modal solution: $x = 10{\cdot}945$; $y = 13{\cdot}51$; $t_0 = 3350$ m.y.

No. of lead sample	Excess Pb^{206} $(a-x)$	Excess Pb^{207} $(b-y)$	$r = \frac{b-y}{a-x}$	t'_0 (m.y.)	'Age anomalies' +	'Age anomalies' −
1	7·905	2·15	0·2720	3350	0	0
2	7·725	1·94	0·2511	3220		130
3	7·455	2·02	0·2710	3340		10
4	7·125	1·89	0·2653	3310		40
5	7·765	2·19	0·2820	3405	55	
6	8·355	2·22	0·2657	3300		50
7	7·155	2·06	0·2879	3380	30	
8	7·255	1·95	0·2688	3270		80
9	6·415	1·95	0·3040	3470	120	
10	7·515	2·15	0·2861	3370	20	
11	7·005	2·06	0·2941	3415	65	
12	7·485	2·10	0·2806	3340		10
13	7·705	1·14	0·3077	3360	10	
14	5·325	1·65	0·3099	3310		40
15	5·125	1·89	0·3688	3425	75	
16	4·985	1·78	0·3571	3360	10	
17	4·985	1·79	0·3591	3315		35
					+385	−395

Sum of squares of 'age anomalies' = 58,900

The relative merits of the above solutions can be tested by a 'least square' method, as illustrated in Table 3, which refers to the modal solution. Knowing a and b (the relative atomic abundances of Pb^{206} and Pb^{207} in each sample of lead) and adopting the modal values for x and y (Table 2), we have:

$$r = \frac{\text{No. of atoms of Pb}^{207}\text{ generated from } t_0 \text{ to } t_m}{\text{No. of atoms of Pb}^{206}\text{ generated from } t_0 \text{ to } t_m} = \frac{b-y}{a-x}.$$

The values of r for various assigned values of t_0 can be computed for each appropriate value of t_m from the formula

$$r = \frac{1}{139} \cdot \frac{e^{t_0\lambda 4cU} - e^{t_m\lambda 4cU}}{e^{t_0\lambda 2U1} - e^{t_m\lambda 2U1}},$$

and for each value of t_m a curve can be drawn showing the variation of r with t_0. From the resulting family of curves the value for t_0 (distinguished as t'_0 in Table 3) corresponding to each value of r in Table 3 can be easily read off.

Ideally, t'_0 should be 3,350 m.y. in each case. The differences between 3,350 m.y. and t'_0, which may be called 'age anomalies', are given in the last two columns. As between the four solutions summarized in Table 1 the 'best' solution should be the one for which the sum of the squares of the 'age anomalies' is a minimum. The results, given in the last line of Table 2, show that the modal solution is slightly better than the average solution without Joplin results; that both are better than the average solution with Joplin results; and that all three are far superior to the preliminary solution originally announced. Moreover, beyond $t_0 = 3{,}350$ m.y., the sums of the squares again begin to increase; for example, a group of solutions averaging $t_0 = 3{,}475$ m.y. gives 61,775 and 297,350 for the respective sums (cf. Table 2). It is, therefore, concluded that, on the evidence at present available, the most probable age of the earth is about 3,350 million years.

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Dec. 5.

[1] Holmes, A., *Nature*, **157**, 680 (1946).
[2] Glaisher, J. W. L., *Camb. Phil. Trans.*, **13**, 243 (1877).

Shift of Aromatic Band in Substituted Benzene

THE aromatic band[1] found in benzene at 671 cm.$^{-1}$ shifts as a consequence of mono-substitution (in benzene) to 740–760 cm.$^{-1}$. In the case of di-substituted benzenes, there is a steady movement to higher frequencies in passing from the ortho- to the para-position; whereas in the case of para-substituted phenols we find that increase in molecular weight of the para-substituent from methyl to octyl does not shift the absorption band, which is found in all these compounds at 825–830 cm.$^{-1}$. Less extensive data on the ortho-phenols show no drift in the aromatic band at 750–755 cm.$^{-1}$ as a result of change in the molecular weight of the substituent from methyl to isopropyl. *m*-Cresol and *m*-ethyl phenol absorb strongly at 780–785 cm.$^{-1}$. It would appear that increasing molecular weight by aliphatic substituents does not shift the aromatic band in the mono-substituted phenols.

In the case of di-substituted phenols the following data were obtained:

1 : 2 : 5	$OH : CH_3 : CH_3$	800 cm.$^{-1}$.
1 : 2 : 5	$OH : C_2H_5 : CH_3$	815 "
1 : 3 : 5	$OH : CH_3 : CH_3$	830 "
1 : 3 : 5	$OH : CH_3 : C_2H_5$	850 "

While the shift of the aromatic band, as a result of a change from methyl to ethyl in one of the two substituents of phenol, is rather more, especially in the case of the 1 : 3 : 5 derivatives, than in the case of the mono-substituted phenols, it should be noted that Whiffen and Thompson's data show a shift of 15 cm.$^{-1}$ in moving from methyl to ethyl in the case of mono-substituted benzenes, and a shift of 36 cm.$^{-1}$ in the case of *p*-xylene and *p*-ethyl toluene. Finally, in the case of 1-hydroxy 2 : 3 : 5 methyl benzene, the aromatic band is found at 840 cm.$^{-1}$. Comparison of this tetra-substituted benzene with the related tri-substituted benzenes is given below:

1 : 2 : 3	$OH : CH_3 : CH_3$	770 cm.$^{-1}$.
1 : 2 : 5	$OH : CH_3 : CH_3$	800 "
1 : 3 : 5	$OH : CH_3 : CH_3$	830 "
1 : 2 : 3 : 5	$OH : CH_3 : CH_3 : CH_3$	840 "

It is evident that adjacency of substituents and degree of substitution affect the shifting of the band, to a greater extent in general than increase in molecular weight of the substituent.

I am indebted to Mr. J. S. M. McKee, who carried out the experimental work.

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Nov. 29.

[1] Whiffen and Thompson, *J. Chem. Soc.*, 268 (1945).

Rate of Growth of Current in Arc Discharges

IF a condenser, charged to a few hundred volts, is connected directly across a small two-electrode tube containing rarefied gas, and a discharge initiated by applying a high-tension triggering pulse near the cathode, the condenser will be discharged in a few microseconds. The discharge is a form of arc, since a 'cathode spot' is necessary to supply the very high currents (a thousand amperes or more) needed to do this, and the applied potential is lower than that associated with glow or spark discharges.

These arcs have been used by many investigators[1] in order to obtain photographs of rapidly moving objects; but a study of the factors within the tube which determine the rate of growth of current seems to have been neglected.

As a result of such a study I have reached the following conclusions about the early stages (that is, the first microsecond) of the discharge. The current density of emission from the cathode spot is greater than 10^6 amp. per sq. cm., and this emitting area generally races over the surface of the cathode at such a velocity that it moves on to new territory in about 10^{-7} sec. Even at such an emission current density, the cathode does not become unduly heated because of the velocity of the spot; thermionic emission is thus very unlikely.

This current density is sufficiently high for field emission to be the most probable cause of the electron current from the cathode. On this assumption one might expect the current in the tube to rise as rapidly as positive ions can be created and carried to the cathode from the 'positive column' close to it. Nearly all the applied potential appears to be taken up by this column. The rate of growth of current is, in fact, found to be greater for a residual gas the ionization coefficient (that is, the number of ion pairs created per cm. per electron) of which is high, and is also increased to a lesser extent by using lighter gases.

For example, in a tube with electrode spacing about 15 mm., connected across a condenser of capacity 2 microfarads charged initially to 300 volts, the current rises from about 1 amp. to 10 amp. in about 12×10^{-9} sec. with the tube filled with air at 2 mm. mercury pressure. It rises by this amount in 6×10^{-9} sec. if filled with argon at 2 mm. pressure, and takes about 4×10^{-9} sec. if filled with helium at 2 mm. pressure.

It is hoped to publish a fuller account of this work in due course elsewhere.

I am indebted to Sir George Thomson for valuable discussion and advice; and to Dr. M. Blackman for discussions on cathode heating.

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Dec. 4.

[1] For references, see Henry, *J. Sci. Instr.*, **32**, 135 (1944).

Heat of Atomization of Carbon

IN a private letter from Princeton dated April 26, 1939, Prof. A. G. Shenstone reported the following observation: "In all cases where I have photographed arcs in N_2 using carbon electrodes I have observed three lines which act like C I lines although I have found no trace of them in the literature. They are in the correct position and have proper intervals to be $sp^3\ ^5S - sp^23s\ ^5P$. They are quite sharp and I think my measures are probably good to ± 0·01 A.:

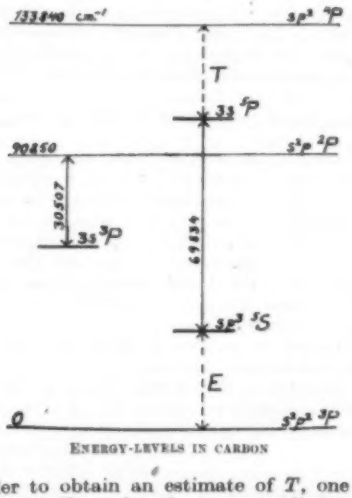
λ	ν		
"1431·595	69852·1	25·3	$sp^3\ ^5S_2 - sp^23s\ ^5P_3$
1432·115	69826·8		– $^5P_2$
1432·538	69806·2	20·6	– $^5P_1$"

The suggested identification of Shenstone's lines is strongly supported by the iso-electronic comparison, as shown in the accompanying table, and is no doubt

	$sp^3\ {}^5S_2 - sp^3 3s\ {}^5P_3$		$sp^3 3s\ {}^5P_3 - {}^5P_2$	
	$(\nu - RN^2\ 5/36) \times 10^{-3}$ cm.$^{-1}$		$\Delta\nu$ cm.$^{-1}$	$\sqrt[4]{\Delta\nu}$
C I	54·61	43·36	45·9	2·603
N II	97·97	43·40	126·6	3·354
O III	141·37	43·55	285·6	4·111
F IV	184·92		559·4	4·863

	0·751
	0·757
	0·752

correct. The discovery and identification of these carbon lines has reduced—as illustrated by the diagram—the problem of finding the excitation energy (E) of the important ^5S-level to the simpler problem of deriving a value (T) of $3s\ ^5P$ with respect to its parent term, the low ^4P of C II. The position of ^4P is fixed through inter-system combinations[1]. From the diagram, in which the figures correspond to the centre of gravity of each multiplet term, one finds $E = 64006 - T$ cm.$^{-1}$.



ENERGY-LEVELS IN CARBON

In order to obtain an estimate of T, one might simply assume T equal to the corresponding quantity (30,507 cm.$^{-1}$) for $3s\ ^3P$ of the main term system. It would seem, however, that some refinement should be obtained by putting the 'centres of gravity' of each of the pair of terms, (^3P) $^3s\ ^3P$, ^1P and (^4P) $3s\ ^5P$, ^3P, at the same distance below their respective limits, and assume the splitting $^1P - {}^3P$ to be about twice the splitting $^3P - {}^1P$. This gives a value for T about 800 cm.$^{-1}$ larger, corresponding to $E = 32{,}700$ cm.$^{-1}$, or $E = 93{\cdot}4$ kcal./mole (using the conversion factor 1 cm.$^{-1}$ = 2·8575 cal./mole). With regard to known structures of similar spectra, the estimate of T should be reliable enough to justify the statement $E = 94 \pm 2$ kcal. In any event, the value around 70 kcal., which has been advocated on the basis of certain thermochemical considerations in the recent discussion[2] on the bond energies of carbon, would be unacceptable.

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[1] Edlén, B., *Z. Phys.*, **98**, 561 (1936).
[2] Long, L. H., and Norrish, R. G. W., *Nature*, **157**, 486 (1946). Valatin, J. G.; Long, L. H., and Norrish, R. G. W., *Nature*, **159**, 237 (1946).

IT is known that spectroscopic data are in agreement only with a series of discrete values for the dissociation energy of carbon monoxide (D_{CO}) and therefore also for the heat of sublimation of carbon (L_C).

The values of 11·11, 9·14 and 6·92 eV. for D_{CO} and 169·8, 124·4 and 73·2 kcal. for L_C have been considered by different authors. However, for each of these values several contradictory spectroscopic arguments can be presented[1].

Among methods used in attacking this problem, we wish to mention the determination of the vapour pressure of carbon. In 1936, Goldfinger and Jeunehomme[2] were able to show by thermodynamic calculations that the vapour-pressure curves for the three possible values of L_C lie far apart, and that, therefore, even rough measurements should suppress the ambiguity. A critical study of the known data, based on the idea that the measured pressure could lie below, but not above the equilibrium value, led to $L_C = 124$ kcal. as the most probable value[2]. This value was also admitted by Goldfinger, Lasareff and Rosen[4], as well as by Herzberg[1], and recently by Mulliken and Rieke[5]. The direct measurement of the triple point of carbon by Basset[6] is in excellent agreement with this value. Nevertheless, several workers do not agree with the interpretation of the experimental results.

Because of the persistent confusion in this important question, it seems necessary to use another method, which is based on the valency state of carbon in its tetrahedric compounds. It is well known that the state of the carbon atom in CH_4 cannot be represented either by ^3P or by ^5S. Van Vleck has shown[7], by a thorough analysis, that the valency state of carbon in methane does not correspond to one of the sp^3 structures of the free atom but is a linear combination of them. He calculates a promotional energy of 7·1 eV. above the normal ^3P level; this state is, therefore, very different from the ^5S level, which according to Edlén lies at 4·2 eV. The identification of the actual state of the combined carbon atom with the ^5S level of the free atom or the neglect of the energy of re-organisation explains the confusion in a number of thermochemical discussions. The interesting points of view brought recently into the discussion[8] show certain apparent contradictions, which disappear by the use of the following method. Let us consider the well-known cycle:

CH_4	= C_{gas} + 4H	−	W
4H	= $2H_2$	+	2 × 102·4
C_{gas} + O	= CO	+	D_{CO}
$2H_2$ + O_2	= $2H_2O_{liq.}$	+	2 × 68·3
C_{sol} + O_2	= CO_2	+	94·5
$2H_2O_{liq.}$ + CO_2	= CH_4 + $2O_2$	−	212·8
CO	= C_{sol} + 1/2 O_2	−	27·6
1/2 O_2	= O	−	1/2 × 117·5

which gives

$$W = D_{CO} + 136{\cdot}8 \text{ kcal.} \quad . \quad . \quad (1)$$

Penney has proposed[9], on the basis of Van Vleck's paper, a formula for the formation energy of methane from normal atoms:

$$W = 4\,E_{CH} - V(v) - 6\,M(H_2), \qquad (2)$$

where $V(v)$ is the activation or promotional energy of the carbon atom in CH_4, and 6 $M(H_2)$ the pairs of steric repulsions between the four hydrogen atoms.

Similarly, the formation energy of the methyl radical is given by:

$$W' = 3\,E_{CH} - [V(v) - w] - 3\,M(H_2), \quad (3)$$

where w is the difference of the promotional energies between CH_4 and CH_3.

The energy D of removal of the first hydrogen atom in methane according to

$$CH_4 = CH_3 + H - D \quad . \quad . \quad . \quad (4)$$

is now well known from several experimental studies[10] and is equal to 100·8 kcal. According to (2), (3) and (4), D is not equal to E_{CH}, but is given by

$$D = W - W' = E_{CH} - w - 3\,M(H_2). \quad (5)$$

By taking E_{CH} from (2) and W from (1) and introducing them into (5) we obtain

$$D_{CO} = 4\,D - 136{\cdot}8 - [V(v) - 4w - 6\,M(H_2)].$$

According to Van Vleck[7] and Penney[9], the values for $V(v)$, $6\,M(H_2)$ and w are respectively 163, 51 and 15·6 kcal., and we obtain thus:

$$D_{CO} = 217 \text{ kcal., or } 9{\cdot}4 \text{ eV.; and } L_C = 132 \text{ kcal.}$$

Considering the uncertainty of about 10 per cent, generally admitted for the determination of $V(v)$, $M(H_2)$ and w, the agreement with the spectroscopic value of 9·11 eV. is very satisfactory, and must be considered as an important argument for $L_C = 124{\cdot}4$ kcal.

We wish to emphasize that the above values of D_{CO} and L_C are independent of spectroscopic data on the CO molecule. They would not be changed by a different interpretation of these data, resulting, for example, from the existence of maxima in the potential energy curves of this molecule.

The concept of promotional energy applies as well to other carbon compounds, especially to aldehydes, ketones and acids, as may be easily understood from the work of Goldfinger, Lasareff and Letort[11]. The method sketched above yields for these compounds promotional energies of about 150 kcal., as compared with Van Vleck's theoretical figure of 163 in methane. We hope to go into details of this question by experimental studies on several free radicals, especially CH_2 and CH_2CO.

It is to be noted that Kynch and Penney[12] have given arguments for $L_C = 170$ kcal. by comparing calculated and observed energies of excited states of molecules with conjugated double bonds. It seems, however, that their conclusions are not definitive, since they neglected to consider the removal of degeneracy of the excited states of butadiene and hexatriene. Further calculations might change their results noticeably, as has already been remarked by Mulliken and Rieke[5].

We may conclude that among all the discussed values, the value $L_C = 124{\cdot}4$ kcal. can alone be accepted, being in agreement with (*a*) spectroscopic data on the CO molecule; (*b*) vapour-pressure data on carbon; (*c*) removal energy of hydrogen from hydrocarbons and promotional energy of C in organic compounds.

On the other hand, by using the relation between the twisting frequency of the ethylene molecule and L_C, one of us has shown[13] that the value 170 kcal. is very improbable.

Finally, it is also very difficult to explain with this latter value the results of Faltings, Groth and Harteck[14] on the photochemical decomposition of CO, as well as the results of the studies on ionization of CO by electron impact[15].

Note added in proof. Voge[16] has obtained a value of the energy of the valency state of carbon which is appreciably lower than Van Vleck's estimate. In connexion with our considerations Voge's value (4·5 eV.) would lead to $D_{CO} \simeq 12$ eV., a figure considerably higher than even the highest possible spectroscopic value. On the other hand, the relative removal energies of the four hydrogen atoms from methane seem incompatible with Voge's result.

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[1] Gaydon, A. G., and Penney, W. G., *Proc. Roy. Soc.*, A, **183**, 374 (1945). Herzberg, G., *Chem. Rev.*, **20**, 145 (1937). Schmid, R., and Gerö, L., *Z. Phys.*, **108**, 36 (1937). These papers discuss the arguments in favour of each of the values quoted as well as those against the intermediate possible values of 8·4 and 9·6 eV.
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[16] Voge, *J. Chem. Phys.*, **4**, 581 (1936).

In view of the fact that the evidence obtained by Prof. Shenstone in 1939 has not yet been published, and that others have not had an opportunity of considering the conditions under which his spectra were obtained, or of examining the spectra as a whole, we feel that the statement made by Prof. Edlén at the end of his letter cannot be accepted as final. In any event, it would appear to us that his argument by analogy requires further confirmation.

The communication of Messrs. Duchesne, Goldfinger and Rosen provides valuable confirmation for the value $L_1 = 125$ kcal. which on other grounds we have advocated[1] as the most probable value for the reaction

$$C_{solid} \longrightarrow C_{gas}\ (^3P).$$

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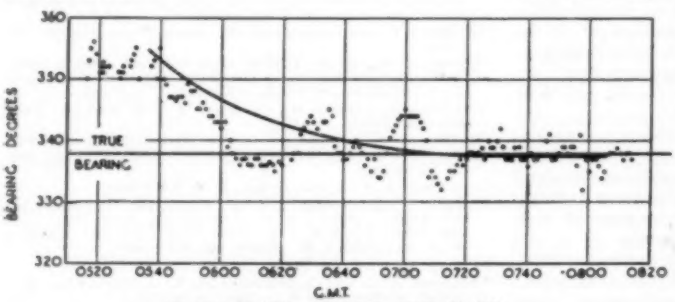
[1] Long and Norrish, *Nature*, **157**, 486 (1946); *Proc. Roy. Soc.*, **187**, 337 (1946).

Lateral Deviation of Radio Waves at Sunrise

THE observation of systematic lateral deviations of radio waves requires that such deviations shall be large enough not to be obscured by the random deviations always occurring. The sunrise period is particularly favourable for such observations, since the relatively rapid changes in ionization at this time produce appreciable horizontal ionization gradients. The direction of these is such as to move the reflexion point of the ray towards the east, and qualitative confirmation of this effect has previously been noted.

Some further observations have been made at the Radio Research Station, Slough, on the British Broadcasting Corporation 6·05 Mc./s. transmitter *GSA* in Cumberland, a distance of about 400 km. from Slough. The experiments were carried out during April and May 1946, the sunrise line being then approximately along the transmission path. The instrument used was a rotating spaced-loop direction finder[1], and the period of observation was two to three hours around sunrise, covering the normal time at which the maximum usable frequency condition was attained.



BEARING OF *GSA* AT SLOUGH, APRIL 12, 1946
·····, observed bearing; ——, calculated bearing

The bearings immediately following the maximum usable frequency condition were usually some ten or twenty degrees to the east of the true direction, which was afterwards gradually approached. This process occupied a time varying on different days from a few minutes up to nearly an hour. Thereafter the bearings showed fluctuations of a few degrees about the true value but no systematic deviations.

A quantitative estimate may be made of bearing deviations to be expected from the changes with time of equivalent height of reflexion, obtained from vertical incidence ionospheric data. Calculations on this basis agree with the directional observations in giving the largest deviations when the frequency is close to the maximum usable frequency, since the equivalent height is then falling most rapidly with advancing time.

Detailed quantitative correlation is not in general possible owing to complications involved by the presence of the extraordinary ray. On one occasion, however, when the observed bearing changes took place comparatively slowly, a simple calculation of equivalent height based on the ordinary-ray transmission alone was found to give good agreement with the experimental results. The observed and computed bearings are shown in the accompanying graph.

The ionospheric data used were obtained from vertical incidence measurements made at the Radio Research Station, Slough, and this note is published by permission of the Department of Scientific and Industrial Research.

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[1] ROSS, W., *J. Inst. Elect. Eng.*, in the press.

Fluid Flow at a Small Hole due to Vibration

PROF. GILBERT WEST has recently described[1] an ingenious experiment in which a stream of smoke-laden air is made to issue from a hole in a cylindrical resonator when an appropriate tuning fork is brought near. This is said to demonstrate the pressure of sound, but I am much in doubt as to whether it does so.

The passage of a sound wave cannot cause any bulk streaming of the air, so that the suggestion is, I take it, that the sound wave exerts a pressure on each smoke particle, as it undoubtedly does on an extended surface. I have pointed out, however, that an ordinary smoke particle takes up practically the full vibratory amplitude of the air at ordinary frequencies; for example, at 600 c./sec. smoke particles of diameter 1 μ acquire 0·9999 of the full amplitude of the sound vibration[2]. In these circumstances no pressure is exerted on them.

Prof. West's experiment is, in my opinion, a demonstration of an interesting effect known to me for many years and first described, I believe, by H. Sell[3]. A cylindrical box is closed on one side by a flat surface carrying a small metal jet: opposite this is a diaphragm which can be set in vibration. When the diaphragm is excited there issues from the jet a stream of air which can blow a light vane aside. The explanation is quite simple. When the diaphragm moves so as to expel the air, the air issues in a well-defined stream; when it moves back so as to suck in the air, the air enters from all sides. The air expelled is equal in volume to that sucked in, but the path of the entering air differs from that of the expelled air, just as the lines of flow of a liquid at the entry of a capillary tube differ from the lines of flow at exit.

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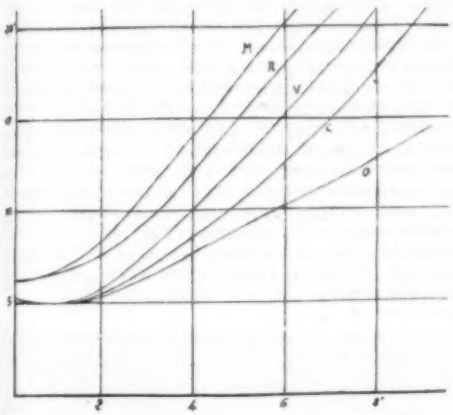
[1] *Nature*, **158**, 755 (1946).
[2] *Proc. Roy. Soc.*, A, **134**, 445 (1931).
[3] *Z. tech. Phys.*, **5**, 573 (1924).

Measurement of Visual Acuity with Blurred Tests

WHEN testing visual acuity with Snellen's current type, we use black letters printed upon a white ground, and the transition from black to white is as abrupt as can be. If the patient's eyes are emmetropic, or hyperopic without presbyopia, or myopic and corrected, the retinal image of the test remains sharp,

and visual acuity is limited only by the structure of the retina and the aberrations of the eye. On the contrary, when the patient's eyes are myopic and not corrected, the retinal images are blurred and visual acuity is poor. This relation of visual acuity to ametropia has been studied by W. Swaine[1], whose measurements one of us has shown to be in fair agreement with theory[2]. But further experiments were necessary.

When an ametropic eye is looking at a sharp test object, it is difficult to measure the blurring of its retinal imagery; but, for the same purpose, we may use an emmetropic eye looking at a blurred test object. Such test objects can be made very easily by the projection of a transparent slide (with opaque letters) upon a diffusing screen which is systematically put out of focus. By this means, we found that various letters resisted this blurring to various degrees, as can be seen from the graph, which shows the



characteristic curves of five letters; the scale of abscissæ gives the apparent diameter, in minutes of arc, of the diffusion circle corresponding to an object point; the scale of ordinates gives, in minutes of arc also, the minimum angle subtended by the heights of the letters when the latter are just recognized; in fact, these heights are those of sharp letters as they would appear on the screen if the aperture of the projection lens were very small. The apparent heights are actually larger, because of the diffusion band, and this fact explains the paradoxical amelioration of acuity which we sometimes observed when images began to be blurred.

Complete results will be published elsewhere, and we hope they will allow a rational classification of Snellen's letters, based upon their resistance to blurring. We hope also to make experiments with an asymmetric blurring, similar to the effect of astigmatism upon vision.

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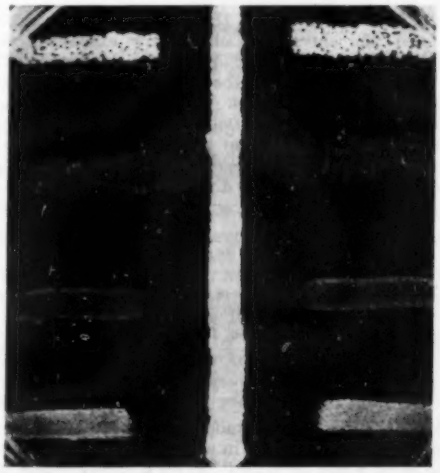
Antibacterial Activity of the Staphylococcus

The observation that the Staphylococcus can inhibit the growth of other bacteria has been recorded in some fifty papers over a period of sixty years, beginning with Babès[1], who showed that a Staphylococcus inhibited the growth of *B. anthracis* and of another staphylococcus. The majority of reports have been concerned with the action of Staphylococci against the diphtheria bacillus. In 1909, Schiøtz[2] recorded the observations that a patient with a staphylococcal sore throat, nursed in a diphtheria ward because of a mistaken diagnosis, did not develop diphtheria, and that carriers became free of the diphtheria bacillus during a non-specific throat infection. There followed a number of attempts, mostly in the United States, to use Staphylococci in a spray to treat diphtheria carriers.

More recently, inhibitory Staphylococci have been examined by a number of workers, of whom Dujardin-Beaumetz[3] was among the first to produce convincing evidence that the inhibition was due to the production of an antibacterial substance.

Experimental As a preliminary to further work, two hundred and five strains of Staphylococcus have been surveyed for their inhibitory power on a solid medium. The strains were obtained through the kindness of Dr. R. L. Vollum, of the Emergency Public Health Laboratory Service. All but six came from human sources. The majority were picked at random off routine diagnostic plates, mostly from nose or throat swabs, some had been isolated from septic wounds at the Birmingham Accident Hospital, and three had been specially selected, being derived from cultures from patients with diphtheria in which difficulty in isolating the diphtheria bacillus had been attributed to the action of an accompanying Staphylococcus.

Agar plates containing 5 per cent serum were inoculated by streaking a loopful of broth culture of the Staphylococcus across the diameter. After the plates had been incubated over-night, selected test organisms were streaked at right-angles on both sides of the primary streak, the size of the inoculum being regulated to give a growth which was just confluent



Inhibition by active Staphylococcus on agar plate. Organisms cross-streaked are, from top to bottom, *Staph. aureus*, *Bact. coli*, *C. diphtheriæ* var. *gravis*, *C. xerosis*

but not heavy. The test organisms used were *Staph. aureus* 'H', N.C.T.C. No. 6571, and laboratory stock strains of *Corynebacterium xerosis*, *C. diphtheriæ* and *Bact. coli*. After re-incubation, inhibition if present was recorded as the distance in millimetres between the edge of the primary streak and the beginning of growth in the secondary streak. Inhibition was invariably symmetrical on the two halves of the plate. The accompanying reproduction shows a representative plate, streaked with an active strain. All the active and eighty-five of the inactive strains chosen at random were tested for coagulose production, and all the active strains for pigment production and fermentation of lactose and mannitol.

TABLE 1. SOURCE AND ANTIBACTERIAL ACTIVITY OF STRAINS OF STAPHYLOCOCCUS

Selection	Source	No. of strains		
		Active	Inactive	Total
Random	nose or throat	20	116	136
	wound	3	51	54
	miscellaneous	0	12	12
	Total	23	179	202
For suspected inhibitory power	throat diphtheria	3	0	3
	Total	26	179	205

Results. Table 1 summarizes the origin and activity of the strains examined. Of the organisms tested, *C. xerosis* was inhibited by all the twenty-six active strains, *Staph. aureus* and *C. diphtheriæ* by most of them, and *Bact. coli* by none. The strains differed in the amount of inhibition which they produced. When arranged in order of activity the gradation from strong to weak inhibition of *C. xerosis*, the most sensitive test organism, was paralleled with *Staph. aureus* and *C. diphtheriæ*. Whether or not each of these organisms was inhibited appeared to be a quantitative rather than a qualitative matter. In additional tests it was shown that the *gravis*, *intermedius* and *mitis* varieties of *C. diphtheriæ* were inhibited about equally, that *C. hofmannii* was inhibited equally with *C. xerosis*, and that *Ps. pyocyanea* and *Salm. enteritidis* (Gaertner) were, like *Bact. coli*, not inhibited at all.

Within the limits of the numbers investigated none of the metabolic characters examined was related to the amount of inhibition produced. The six active *albus* strains, for example, were scattered evenly through the series. It was further shown, in respect of one metabolic character, namely, coagulase production, that the proportion of strains possessing it was the same among the active Staphylococci and among eighty-five of the inactive strains chosen at random. The figures are given in Table 2.

TABLE 2. PRODUCTION OF COAGULASE BY STAPHYLOCOCCI ACTIVE AND INACTIVE AGAINST BACTERIA

Antibacterial activity	No. of strains		Per cent positive
	total examined	coagulase positive	
Present	26	19	73
Absent	85	56	66

Some strains of Pneumococcus and Streptococcus form hydrogen peroxide in sufficient quantity to produce wide zones of inhibition on a streak plate, but this has never been reported for the Staphylococcus. That it did not account for any of the inhibitory activity of these strains was established first by the differential nature of the inhibition, since peroxide inhibits all the test bacteria about equally, and secondly by reproducing the activity of all strains on a medium containing catalase.

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[1] Babès, V., *J. Conn. Méd. Prat. Paris*, **7**, 321 (1885).
[2] Schiøtz, A., *Ugeskrift f. Læger, Copenhagen*, **71**, 1373 (1909).
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Rhythmical Impedance Changes in Salmon Eggs

THE protoplasmic membranes of fertilized and unfertilized trout eggs undergo periodic structural changes after being in tap-water for about seven hours. These changes are associated with variations in electrical impedance[1]. The frequency of the impedance change is approximately 1/1·5 min., and the effect can be abolished reversibly by phenyl urethane[2]. Through the kindness of Prof. J. H. Orton, of the University of Liverpool, and Mr. G. M. King, of the Dee Fishery Board, fertilized and unfertilized salmon eggs have been examined in the same way as trout eggs, in an alternating current-bridge of high sensitivity, with a visual detector. Salmon eggs undergo periodic impedance changes (Fig. 1), which are remarkably similar to those previously observed in trout eggs. Their frequency at 16·5° C. is approximately 1/3 min.

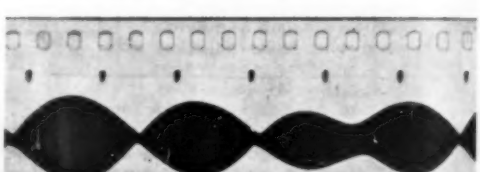

FIG. 1. PERIODIC IMPEDANCE CHANGE IN FERTILIZED SALMON EGG, TWO DAYS AFTER FERTILIZATION. TIME-MARKER, MINUTES

As in the trout egg, the impedance cycle can be resolved into two components: a 'fundamental' change, and another with one half the frequency, which has the effect of making every fourth bridge balance less sharp than the previous three. In some eggs, particularly those which are more than two days old, this effect is very marked.

The trout egg impedance cycle has been analysed in terms of the vitelline membrane resistance and capacitance, and it i found, somewhat surprisingly, to be mainly capacitative[3], though small changes in resistance may be difficult to observe if the membrane resistance is very high. The same applies in the salmon egg. A salmon egg circle diagram (time-admittance locus, similar to the 'time-impedance locus' described by Cole and Curtis[4]) is shown in Fig. 2.

It will be seen that the $1/R_p$, ωC_p co-ordinates at different times but at the same frequency lie on an arc of a circle, indicating that the impedance change seems to be mainly due to a change in membrane capacitance. There is only a very slight suggestion

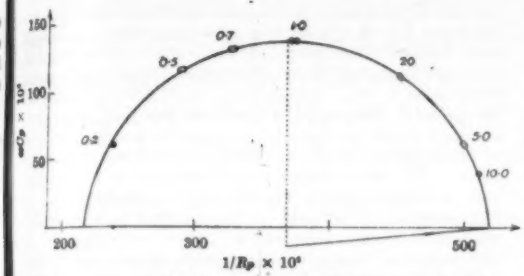

FIG. 2. TIME ADMITTANCE LOCUS OF SAME EGG AS IN FIG. 1, SHOWING THE CO-ORDINATES $1/R_p$, ωC_p, OSCILLATING ALONG AN ARC OF A CIRCLE. FREQUENCIES IN KILOCYCLES

that membrane resistance is involved. The membrane phase angle is 84°, and the membrane impedance is of the form $|z| = K\omega^{-2\phi/\pi}$. There is no change of phase-angle during the impedance cycle.

The meaning of these impedance cycles will only become clearer when eggs, or other cells which exhibit this phenomenon, are put through their physiological or biochemical paces. So far, these eggs are the only living material in which such changes have been observed; they may be peculiar to this type of egg, which is morphologically somewhat specialized. On the other hand, these eggs are specially suitable for very sensitive measurements of bio-electrical properties, as they present the experimenter with a thin spherical shell of protoplasm the area of which is nearly 1 sq. cm. Other material might not be so favourable for the observation of these rhythmical changes in protoplasmic structure.

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[1] Hubbard, M. J., and Rothschild, Lord, *Proc. Roy. Soc.*, B, **127**, 510 (1939).
[2] Rothschild, Lord, *Nature*, **145**, 744 (1940).
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Unco-ordinated Growth in *Paramecium* Induced by 'Gammexane'

THE γ-isomer of hexachlorocyclohexane ('Gammexane') is toxic to *Paramecium caudatum* when introduced into the cultures at a rate of 10 parts per million down to 1 per million. The action of the poison is slow and cumulative, the organisms continuing to feed until near death. Nuclear division is inhibited, and so they become hypertrophied, increasing in length and breadth up to 50 per cent beyond normal. There is a threshold concentration of the drug somewhere between 1 and 0·5 parts per million where some normal division occurs, but a proportion of the hypertrophied cells divide as to the nuclei but not as to the body of the cell itself. Consequently, Siamese-twin forms are produced which feed and live a long time without making further progress, except that a small lateral outgrowth sometimes suggests that they might produce buds. Complete budding has not been observed in the 'Gammexane'-treated medium.

When the twin forms, or highly hypertrophied *Paramecium* from the lower 'Gammexane' concentrations, are placed in normal medium, macronuclei and micronuclei divide repeatedly while the cell throws out lobes in all directions. As many as fourteen micronuclei have been counted in one individual while the macronucleus was throwing off pieces of varying size. Buds become detached with varying nuclear combinations, and while it is likely that all these buds are not viable, some of them succeed in starting fresh colonies of apparently normal individuals. These budding forms have several times the bulk of a normal *Paramecium*, are ciliated all over in the normal way, and have a pharynx or sometimes two pharyngeal openings. They feed, and the cilia are active; small ones swim, but the large ones contort themselves and roll over constantly but are too heavy to move from the floor. The accompanying illustration shows the normal form of *Paramecium* and some of the smaller abnormal forms drawn from life. It should be noted that while the pressure of the drug is on them, only simple Siamese twins

NORMAL *Paramecium* AND FORMS DISTORTED BY 'GAMMEXANE'. (*a*) NORMAL; (*b*) THE SIAMESE TWINS; (*c*), (*d*), (*e*) SMALL BUDDING FORMS; (*f*), (*g*) FREED BUDS. ALL ARE FULLY CILIATED. DRAWN FROM LIFE

are formed; but when this pressure is relieved the fully unco-ordinated growth occurs. In a manuscript on this topic by the late J. C. Mottram, who has recorded these abnormal growths in *Paramecium* after contact with several of the cyclic hydrocarbons[1], emphasis is also laid on the two factors, one sensitizing and the other developing.

This development arises out of my connexion with the informal committee on sewage filter-flies of the Water Pollution Research Board (Department of Scientific and Industrial Research). My thanks are due to the officers of the Board for the supply of materials. A full account of the method of obtaining these abnormalities and of the behaviour so far observed will shortly be ready for publication.

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Nov. 30.

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Polyploidy in *Polypodium vulgare*

THE common polypody (*Polypodium vulgare* L.) is such an apparently well-defined and isolated species, being the only one of its kind hitherto recognized in Europe, that it was a matter of considerable surprise to detect in it cytological complexities recalling those of the Male fern[1] without, fortunately, quite equalling the full intricacies of that 'species'. *Polypodium* is, however, complicated enough to need a very large collection of living samples from all over its geographical range before it will be adequately understood, and it is in the hope of soliciting the co-operation of correspondents both in Great Britain and farther afield that this note has been offered for publication.

Polypodium sporangia mature late in the season (August or September in northern England). The first chromosome count made with any pretension to accuracy was obtained in September 1944 from a normal-looking and apparently wild plant in the grounds of the Biological Station at Wray Castle (Windermere). One cell is shown in Fig. *a*, and the chromosome number, known to be accurate to within three chromosomes, was at first recorded as $n =$ 'approx. 112'; there is now (see below) strong reason for believing that the correct number for this plant is $n = 111$.

In the hope of removing the slight uncertainty hanging over the original count, fixings were taken in July 1946 of some well-known greenhouse strains of the species kindly placed at my disposal by Dr. Cromwell of Hull. Far from confirming the original count, these fixings revealed an entirely different situation. Vars. *semilacerum* and *omnilacerum* had $n = 37$ with no uncertainty of any kind regarding the number (see Fig. *b*), and var. *cornubiense* had $n = 74$. It is clear that the numbers 37, 74 and 111 form a polyploid series, which is the reason for believing that 111 and not 112 is the correct number for the Windermere specimen. None of these plants showed any sign of multivalents.

It was obvious, however, that most if not all of these specimens could have been modified by man, for the vars. *semilacerum*, *omnilacerum* and *cornubiense* are known to have been in cultivation for more than half a century since their first discovery as wild 'sports', and the Windermere plant from its position in the grounds of Wray Castle could have been a garden escape. Further collections of normal wild material were, therefore, necessary to establish the basic facts for the wild species.

Preliminary results of such a survey have confirmed the reality of the problem. The hexaploid (as the Windermere plant may be called) has not so far been found again, but specimens from a wood near Kendal (Westmorland) and from a very remote spot on Rannoch Moor (Perthshire) were tetraploid (that is, $n = 74$). Diploids ($n = 37$) were found at Dartmouth (Devon), the Cheddar Gorge (Somerset), and in a plant brought back from the neighbourhood of Montpellier (Pont du Gard) in southern France in 1946. The Montpellier plant belongs to *P. vulgare* var. *serratum*, which is the only representative of *Polypodium* in that part of Europe, and it is probable that the British diploids will also be referable to var. *serratum*, though their characters are less clearly defined than in the French material.

While it seems highly probable that 'var. *serratum*' will need to be recognized as a second European species of *Polypodium*, it is clearly desirable, before this is done, for information on a much larger scale to be assembled. All forms of *Polypodium* are easily recognizable as such even by amateurs, and they are remarkably tolerant of rough handling. If firmly wrapped to prevent desiccation, they will probably survive a postal period of several weeks.

I would be very grateful for any living specimens that can be sent to me from Great Britain, Europe or America, provided that the place of origin is clearly indicated. To facilitate transmission from abroad, non-British parcels may be addressed to the Keeper of the Herbarium, Royal Botanic Gardens, Kew, Surrey.

I. MANTON

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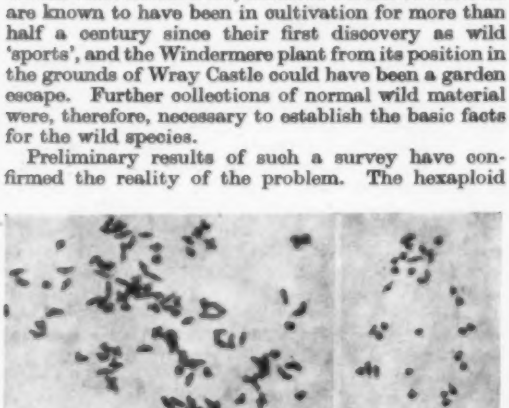
Dec. 10.

[1] Manton, I., *Nature*, **144**, 231 (1939).



a *b*

MEIOTIC METAPHASES IN ACETOCARMINE OF A HEXAPLOID AND A DIPLOID *Polypodium*. × 500. (*a*) MORPHOLOGICALLY NORMAL SPECIMEN FROM WINDERMERE; (*b*) THE HORTICULTURAL VARIETY 'SEMILACERUM'

Effect of Temperature of Storage on the Rate of Loss of Fertility of Stock Cultures of *Melanospora destruens*

MYCOLOGICAL literature contains many references to loss of fertility by fungi in culture. During an investigation of the physiology of perithecial production in *Melanospora destruens* Shear, the strain became progressively less fertile. Fertile saltants developed in cultures grown at the relatively high temperature of 37° C. These were isolated and their growth-rates were compared with those of sterile saltants at various temperatures.

At relatively low temperatures, namely, laboratory temperature (18° C.) and 20° C., growth of the sterile strains began several hours before that of the fertile ones. At 25° C. the difference was reduced, while at 30° C. and above, the growth-rates of the sterile and fertile strains were approximately equal.

Thus it is clear that if stock cultures of this fungus are kept at laboratory temperature, the chances of picking up any sterile saltants present when subculturing would be greatly increased, since these are likely to become established before the fertile ones commence growth, and so would probably prevent the development of the latter. If, however, the stock cultures were incubated at 30° C. for at least two days after subculturing, the chances of survival of the fertile strains would be greatly increased. This problem is being investigated, and it is hoped to publish a fuller account later.

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Dec. 18.

MECHANISM OF HIGH ACID PRODUCTION BY YEAST AND ITS BEARING ON HYDROCHLORIC ACID FORMATION IN THE STOMACH

By Prof. EDWARD J. CONWAY
AND
Dr. THOMAS BRADY
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As previously described[1], when baker's yeast ferments unbuffered glucose solutions, a high degree of acidity can be reached if potassium chloride in the suspending fluid is brought to about 0·1 *M*. With simple variations of the conditions, *p*H values as low as 1·49 have now been occasionally observed, and often a *p*H of 1·6.

The high acidity arises from an exchange of hydrogen and potassium ions[1]. In the search for the source of the hydrogen ions, we were at first influenced by the view that one acid would be largely if not entirely involved, and probably an acid with *p*K value as low as 2–3. From the inhibiting action of fluoride and iodoacetic acid, such an acid could be expected at or below the level of pyruvic acid. A parallelism was found[1] between the rate of pyruvic acid production and the acidity, and very probably this acid (as well as phosphopyruvic acid) plays a part in potassium and hydrogen exchanges, but it accounts only for a small fraction, as appears from the quantitative relations. The truth seems to be that various acids formed in the breakdown of the sugar can take part, but the evidence shows that the major part of the exchange is due to succinic and carbonic acids, the latter free or protein-linked. It may be noted that when yeast carboxylase acts on pyruvic acid, carbonic acid (H_2CO_3) is directly formed and not carbon dioxide[2], and a fuller investigation of the question has now provided evidence that it can largely participate in the hydrogen ion exchange, though it is not clear so far if it does so directly or as some protein-linked compound.

Evidence for the participation of succinic acid. When yeast ferments glucose under the conditions described above, succinic acid appears in the fluid outside the cells, rapidly and in surprising quantity. At the same time the concentration of succinic acid in the cells is only a small fraction of that outside. If potassium chloride be present in the suspending fluid (to about 0·1 *M*) considerably less succinic acid appears in the free fluid, but an amount corresponding largely with this reduction is retained inside the yeast cells, the potassium chloride having at the same time little or no effect on the average rate of production of carbon dioxide.

The accompanying table gives the mean data for three experiments:

Nature of suspension (1 pt. of moist yeast to 0·6 pt. suspending fluid, mgm. per cent)	Succinic acid in the suspension (mgm. per cent)	Succinic acid in fluid after centrifuging (mgm. per cent)	Succinic acid in yeast cells (calculated value) (mgm. per cent)	*p*H of suspension
Without KCl	85	155	12	3·03
With KCl	78	111	44	1·97

The interspaces between the cells had a mean value of 22 c.c. per 100 gm. yeast as shown by studies of the inulin space.

The succinic acid retained in the cells in the presence of potassium chloride accounted for approximately 45 per cent of the hydrogen and potassium ion interchange, assuming one of the ionizing groups (*p*K of 4·2) to contribute the hydrogen ions. Further supporting evidence for the contribution of succinic acid in the hydrogen and potassium ion exchanges could also be furnished.

If another *organic* acid were associated with the exchange, it could be expected to appear like succinic in the suspending fluid; but analysis shows that upwards of 80–90 per cent of the organic acid in the suspending fluid is, in fact, succinic.

Evidence for the participation of carbonic acid in the potassium and hydrogen ion exchanges. When, in such experiments, whether conducted *in vacuo* or at atmospheric pressure, or again when through fermenting mixtures carbon dioxide is freely bubbled at atmospheric pressure, in the presence of potassium chloride there is found in nearly all cases an excess of acid-labile carbon dioxide (other than free carbon dioxide). This, on the average, is sufficient to account for a high proportion of the potassium and hydrogen ion exchange (about 40–50 per cent, but occasionally higher). The excess of acid-labile carbon dioxide increases up to 30–50 min. and then falls as the fermentation decreases.

Bearing of these experiments on hydrochloric acid production by the gastric mucosa. The apparent participation of carbonic acid (or of some immediate associate) in the high acid production by yeast is of special interest for hydrochloric acid formation by the gastric mucosa. The view has been previously advanced by Davenport and Fisher[3] that carbon dioxide is associated with this production, the change to carbonic acid being catalysed by carbonic anhydrase; but the view that this enzyme plays a direct part in the hydrochloric acid formation appears no longer tenable[4]. The literature up to recent years has been summarized by Hollander[5] and by Babkin[6].

Here it is considered that the entrance of carbonic acid is quite the opposite of that proposed by Davenport, for free carbonic acid and not carbon dioxide is formed by carboxylase on pyruvic acid (and in such decarboxylation it may be presumed to be always so formed). At the same time, it is probable that it is not the H_2CO_3–HCO_3' system that is the fully operative mechanism, but that protein-linked carbonic acid is associated, helping to damp down the rate of passage to carbon dioxide gas.

In recent studies on the respiratory exchange and hydrochloric acid production with the gastric mucosa of the frog[7], Davies and co-workers appear to have obtained results of much value. From their account it would seem that they have obtained occasionally Q_{HCl} values much higher than Q_{O_2} figures. At the same time, it may be noted that when Q_{HCl} exceeded twice Q_{O_2}, with the mucosal sack immersed in bicarbonate saline, the tissue appeared damaged, and in phosphate saline the damage seemed obvious with Q_{HCl} just above the Q_{O_2}.

The findings of Davies—so far indicated—in no way disprove the essentials of the theory proposed from their Department as to the manner of the hydrochloric acid formation. In this theory potassium chloride is first excreted as a neutral chloride, and

then potassium ions are exchanged for hydrogen ions across a membrane, the latter ions being furnished in the metabolic processes of the cell. It is clear that the simplest source of such hydrogen ions could be the carbonic acid formed metabolically, but this may be supplemented by organic acid formation, and especially when the tissue is not in good condition, in which case Q_{HCl} may exceed Q_{O_2}. At the same time, it is possible that a cyclical formation of an acid such as phosphopyruvic could occur at the site of the hydrogen ion exchange, and then be reversed to a substance of weaker acidity within the cell. The actual concentration of the operating acid need only be small, but charging the membrane with a relatively high concentration of hydrogen ions. Such a cyclical process could give Q_{HCl} values far higher than Q_{O_2} values, the ratio being limited only by the available energy and the efficiency of its utilization—a limiting condition of any process involved in the formation of hydrochloric acid.

Concerning the action of carbonic anhydrase (which was shown by Davenport to be present in relatively large amounts in the gastric mucosa, and in the stomachs of cats, rats and dogs to be present almost exclusively in the parietal cells), any view which considers the anhydrase to hasten the change of carbon dioxide to carbonic acid at the site of its formation is very probably incorrect. This is so because of the analogy of the yeast carboxylase action[8], and the structure of the carboxylic acids; and all decarboxylations may be considered as involving a primary formation of carbonic acid. But when, as the result of the processes above considered, HCO_3' ion accumulates, the excretion of this ion into the blood may be accelerated by conversion to carbon dioxide (hastened by carbonic anhydrase) and by a chlorine ion and HCO_3' exchange.

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[2] Conway, E. J., and MacDonnell, E., *Nature*, **156**, 752 (1945).
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[5] Hollander, F., *Gastroenterology*, **1**, 401 (1943).
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[7] Davies, R. E., *Biochem. J.*, **40**, Proc. xxxv (1946).
[8] Davies, R. E., and Longmuir, N. M., *Proc. Biochem. Soc.* (1946).

HIGH POLYMERS

STRASBOURG CONFERENCE

AN international conference on high polymers was held at the University of Strasbourg during the week of November 25. This is the first of a number of conferences on special subjects to be held in France, arranged by the Centre National de Recherche Scientifique, under the sponsorship of the Rockefeller Foundation. Each conference is designed for the intensive discussion of current research by a relatively small group of French and foreign men of science.

The papers presented at this conference were restricted to the subject of the molecular properties of large molecules, for it was felt that a discussion extending over the entire field was impractical. The programme was as follows: W. T. Astbury (Great Britain), X-ray research on the structure of chain-like molecules; M. L. Huggins (United States), statistical thermodynamics of polymer solutions; G. Gee (Great Britain), statistical thermodynamics of polymer solutions; Mme. A. Dobry (France), incompatibility and demixing of macromolecules; H. Benoit (France), statistics of polymer molecules; C. Sadron (France), the particle equivalent of a polymer molecule; M. Gibert (France), measurement of translational diffusion; M. Calvet (France), measurement of translational diffusion; A. Banderet (France), ultracentrifugal studies of cellulose glucolic acids; P. Kinell (Sweden), sedimentation in the ultracentrifuge; R. Signer (Switzerland), streaming birefringence in polydisperse media; P. Doty (United States), scattering of light from polymer solutions; M. Magat (France), viscosity studies on *GRS* solutions; G. Gee (Great Britain), statistical thermodynamics of gels; M. L. Huggins (United States), theory of rubber elasticity; P. Doty (United States), swelling of polymer networks; J. J. Hermans (Holland), deformation of cellulose gels; G. Champetier (France), solvation and swelling of cellulose derivatives; P. H. Hermans (Holland), crystalline and amorphous states in cellulose fibres; J. Chedin (France), ageing of nitrocellulose solutions; M. Mathieu (France), mechanisms of dispersion; P. Grabar (France), action of ultrasonics on macromolecules.

It is hoped to print these contributions in the January 1947 issue of the *Journal de Chimie Physique*.

The final session of the conference was devoted to a discussion of the problems of publication and the possible formation of an international union of workers on the science of macromolecules. It was felt that the most desirable publication policy would involve an international journal of the following type. Each article would be printed in English and in either French, Russian or German according to the author's choice. Such a journal should include articles of general importance, articles based upon completed research, and reviews. Papers reporting the progress of research and of less general interest should appear in national journals and be abstracted in the international journal. The consummation of such a scheme as this is probably not possible without an international organisation. The informal offer to adapt the *Journal of Polymer Science* in the direction of these recommendations was welcomed.

Members of the conference were generally agreed on the desirability of a permanent international organisation capable of surveying the diverse scientific fields involved in the study of macromolecules. The administration of such an organisation, which would not be concerned with the technical uses of macromolecules, could perhaps be carried out by representatives of the member organisations; its duties should include: (1) active co-operation with the United Nations Educational, Scientific and Cultural Organisation; (2) planning and procuring financial aid for international conferences; (3) co-ordination of publication and subsidizing of an international journal; (4) facilitation of international exchange of research workers and substances; perhaps a store of highly purified macromolecules the physical properties of which had been carefully measured could be established.

All these discussions are preliminary and are reported for the purpose of initiating more universal consideration of these proposals. In order that the general feelings of workers in the field of macromolecules can become known, it is requested that those interested communicate with either Dr. M. L. Huggins, Kodak Research Laboratories, Rochester, N.Y., or Prof. Charles Sadron, Institut de Physique, 3 rue de l'Université, Strasbourg.

ELECTRODEPOSITORS' TECHNICAL SOCIETY

PROGRESS AND DEVELOPMENT

THE Electrodepositors' Technical Society was founded on December 9, 1925, so it has now come of age.

The inaugural meeting took place at the Northampton Polytechnic, Clerkenwell, which remained the Society's headquarters until very recently, when larger offices had to be secured to cope with the increasing membership. The Society, which first received the title "The Electroplaters and Depositors' Technical Society", was formed under the ægis of the Faraday Society, the secretary of which, Mr. F. Spiers, did much of the initial work in association with Mr. S. Field, at that time head of the Chemistry Department of the Northampton Polytechnic, Mr. W. James and Mr. W. E. Harris. The three latter individuals became the first president, honorary treasurer and honorary secretary respectively of the newly formed Society. Dr. S. Wernick, who took over the honorary secretaryship shortly afterwards, in 1927, and remained continuously in this office until 1945, has taken a prominent part in shaping the Society's policy. He is now its president.

The main object of the Society, namely, the publication and dissemination of information relating to electrodeposition and allied processes, has been faithfully carried out, as testified by the twenty volumes of *Transactions* which the Society has thus far published. Some hundreds of meetings have been held regularly, both at the London headquarters, and in Birmingham at the James Watt Memorial Institute, the headquarters of the Society's Midlands Centre. The recent War seems only to have given a further impetus to the Society's activities, and meetings continued to be held during the height of the bombing attacks on the capital and in the Midlands. The membership has steadily increased during this period, there being more than eight hundred active members enrolled at present.

The published papers are of a high standard and record the considerable development which has taken place in electrodeposition theory and practice. Much of the published work represents original research carried out during the past two decades in Government and industrial laboratories and research institutes. The work of the 'Woolwich' School, led by Mr. D. J. MacNaughtan (succeeded by Mr. A. W. Hothersall), occupies a prominent place in the Society's publications; much of the latter work was carried out in association with the British Non-Ferrous Metals Research Association. The publications prove convincingly that pioneer work in Great Britain on electrodeposition does not lag behind that of any other country in the world, despite the fact that, particularly in the United States, research facilities are superior, research being more generously endowed by an industry which is approximately some ten times the size of that of Great Britain. This record of continuous publication has been achieved by a relatively small society with slender financial resources, and is surely a striking testimony to the vigorous effort and ability displayed throughout by those honorary officials who have worked zealously in the Society's cause. Until recently the Society employed no paid clerical staff, practically the whole of its income being devoted to the issue of publications. In order to cope with the increased financial burden envisaged by future publications, the Council has lately opened a Publications and Development Fund, and donations to this Fund will be solicited from industrial undertakings which have directly or indirectly benefited from the Society's activities to date. It is hoped to raise a fund of £10,000 for this purpose.

Apart from its publishing activities, the Society has done much in disseminating information on electrodeposition and allied processes by organising exhibitions and conferences on numerous occasions; thus, in 1931, it organised the section on electrodeposition, electroplating, electro-forming, etc., at the Faraday Centenary Exhibition, which was held at the Albert Hall in London. In 1935, an Electrodeposition Exhibition was organised at the Science Museum, South Kensington; this proved to be one of the most comprehensive exhibitions dealing with all phases of pure and applied electrodeposition ever brought together in Great Britain.

The Society was also responsible for organising the First International Electrodeposition Conference, held in London in 1937; it was attended by leading authorities in this field of technology from many foreign countries, who contributed papers on different aspects of electrodeposition. Just before the outbreak of war in 1939, the American Electroplaters' Society followed this lead by holding the Second International Electrodeposition Conference in New York. The third has already been planned by the Electrodepositors' Technical Society, and will be held, it is hoped, in London in May of this year.

The Society has done much useful work in the field of standardization. Its permanent Standards Committee, under the chairmanship of Mr. E. A. Ollard, has worked unceasingly in the interests of laying down specifications to be used by the industry, covering not only the purity of chemicals and materials employed, but also the quality of the electrodeposits produced. One of the first tasks of this Committee was to revise the glossary of scientific and technical terms relating to electro-chemistry, etc., and thus produce the first comprehensive vocabulary, which has been of very material value to technicians ever since. With regard to standardization, one of the most recent specifications issued by the British Standards Institution, with which body the Society has worked very closely, covers the popular finishes, nickel and chromium plating. This is a signal achievement in view of the considerable controversy which arose on the possibilities of producing a specification which would be acceptable alike to technicians and industrialists.

At the official celebration of the Society's twenty-first anniversary, a large number of members and visitors met at the Northampton Polytechnic. Representatives of sister societies were present, and messages from the Chemical Society, Royal Institute of Chemistry, Institution of Electrical Engineers, Faraday Society, American Electroplaters' Society, Electrochemical Society, and a number of Continental bodies were read. Examples of some of the latest types of electrodeposits and some of the newly developed instruments for the control of electrodeposition were exhibited. Among the past presidents present were Mr. S. Field, Prof. R. S. Hutton, Mr. E. A. Ollard, Mr. A. W. Hothersall, Dr. H. J. T. Ellingham and Dr. J. R. I. Hepburn.

During the meeting, the president, Dr. S. Wernick, announced the Council's decision to institute a medal,

to be known as the E.T.S. Medal, which would be awarded annually or at longer intervals to individuals who had performed outstanding service in the field of electrodeposition. It is hoped that the scope of the Medal will be international. It had been unanimously decided by the Council that the first recipient of the Medal should be the first president of the Society, Mr. Samuel Field. A scroll was formally handed by the president to Mr. Field as a token of the award, as it had not been possible to cast the Medal in time for the celebration; it is hoped that it will be possible to present the Medal itself on the occasion of the Third International Electrodeposition Conference.

PRESENT STATE OF SOME GERMAN MUSEUMS

By FRANCIS J. GRIFFIN

IN *Nature* of May 11, 1946, p. 631, I gave some information on the condition of a number of German museums and their contents. I have recently heard from Prof. Martin Hering, of the Zoological Museum, Berlin, giving me more up-to-date information, which can be summarized here.

On January 1, 1946, Prof. Hering writes, the Russians returned the Zoological Museum to the University of Berlin, and it has now resumed work under its old title of Zoological Museum of the University. At the same time the hymenopterist, Prof. Werner Ulrich, was appointed director of the Museum, a post he holds simultaneously with that of director of the Zoological Institute of the Agricultural Faculty (formerly Agricultural High School) and that of director of the Institute of Agriculture. This appointment has met with general satisfaction.

The entomological collections of the Museum have survived the War undamaged in the cellars, with the exception of the Lepidoptera. This section is the most heavily damaged part of the Museum, but the roof has been repaired and the windows made weather-proof, partly with glass and partly with cardboard, so that damp can be kept out; the final drying out, however, must wait until next summer, since the walls are still too wet. For this reason, the Lepidoptera and Coleoptera will not be brought up from the cellars until next spring, and until then it will not be possible to see whether the conditions in the cellars have caused any damage. The collections have been there since 1943. Sampling suggests that no damage has been caused.

Dr. Deckert has returned from a prisoner-of-war camp and will resume his work shortly.

The library of the German Entomological Society is now in safety and no longer threatened by dampness; the damage is not so great as had been feared. All the Society's entomological periodicals were removed to the cellars, where they have suffered little, apart from a certain amount of mould on the bindings which is easily removed. Unfortunately, the Society has still not obtained permission to resume its activities. At the instance of the British Military Authority, a request was made in April to the Berlin Town Authority (*Magistrat*) for permission to start up again, but no answer had been received when writing. Prof. Hering adds that this is the more regrettable since the Society was not involved in Nazi politics and refused to eject its Jewish members.

There is good news of Prof. Hering's famous "Minen-Herbarium". After having been plundered, it was largely brought together again by the schoolteacher of the town to which it was sent, and is now restored to its rightful owner. Most of the lost specimens have been replaced, and Prof. Hering is now able to work again at his chief subject. Unfortunately, a few unique specimens are lacking. Of the 18,000 insects bred from the leaf-mines which were removed to the air-raid shelter in the Wilhelmsplatz, all have safely survived, including all the types.

Dr. Kaestner has written that the greater part of the surviving entomological material from the Stettin Museum has now been removed to Lublin. Dr. E. Urbahn, the lepidopterist, is not dead, as was thought, but is living at Zehdenick, near Berlin. His collection, which was housed in the Stettin Museum, was, however, destroyed before the removal of the latter.

The dipterist, W. Hennig, formerly at the German Entomological Institute at Dahlem, is at present working at the Zoological Institute of the University of Berlin.

The German Entomological Institute was, as I have already reported, evacuated to Blucherhof, Post Vollratsruhe, Mecklenburg, where it, and the library, is undamaged. Dr. Sachtleben is still director, and the Institute is now united with the Biologisches Zentralanstalt (formerly Reichsanstalt).

R. Friedlander and Sohn, booksellers and publishers, have resumed business under their own name, and their present address is Dorotheenstrasse 75, Berlin.

Max Gaede, collaborator in the Seitz book, died last spring, and K. M. Heller, coleopterist and Rhynchophora specialist, is also dead. Dr. Sick, a collaborator in Seitz's book, and latterly editor of the Geometridæ, is unable, for reasons of health, to continue work.

The publishing house of Gustav Feller, of Neubrandenburg, has been completely burned out, and the whole stock of the "Catalogus Lepidopterorum" and all the other catalogues of this publisher, as well as Hering's "Blattminen Mittel- und Nordeuropas", is lost.

Prof. E. T. Titschack, formerly of the Hamburg Museum, was a Nazi and now lives near Bitterfeld.

Of the large work, "The Zoology of Peru", everything not already distributed is destroyed.

H. G. Amsel, microlepidopterist, of the Bremen Museum, was a Nazi and has been turned out of the Museum.

Klaus Günther, orthopterist, of Dresden, is alive, as is Prof. F. Peus, dipterist, who is now entomologist at the Museum in Munster, in Westphalia.

The following are also alive: Prof. Ferdinand Paz, formerly of Breslau and now in the Harz; Prof. Max Draudt, successor to Seitz in the editorship of the "Grossschmetterlinge der Erde"; and Prof. K. Escherich, formerly of Munich, now near Tegernsee.

Dr. Riehm, president of the Biological Central Station for Agriculture and Forestry (formerly "Reichsanstalt") in Dahlem, has been removed as a Nazi, and his successor is Dr. Schlumberger; while the present lecturer at the Agricultural Faculty of the University of Berlin is Dr. Fritz Zimmermann, formerly lecturer in entomology at Tetschen in Czechoslovakia and a microlepidopterist.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, January 27

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Dr. A. Dickson Wright: "The Advances of Modern Surgery" (Cantor Lectures, 1).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "National Certificates and their relation to the Needs of Industry" (to be opened by Mr. S. E. Goodall).

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (joint meeting with the MANCHESTER SECTION OF THE INSTITUTION OF THE RUBBER INDUSTRY, at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. F. A. Jones: "The Chemistry and Technology of Organo-Silicon Compounds".

Tuesday, January 28

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. H. S. W. Massey: "Semi-Conductors".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. P. H. J. Johnson: "The Principles of Manual and Automatic Telephone Exchanges".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. W. C. Fahie: "Some Applications of Electronics in the Iron and Steel Industry".

Wednesday, January 29

TEXTILE INSTITUTE (at the University, Leeds), at 10.30 a.m.—Conference on "Modern Methods of Single Fibre Testing".

PHYSICAL SOCIETY, COLOUR GROUP (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Mr. H. D. Murray: "The Use of Colour in Factories".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Mr. Walter C. Puckey: "Economic Reconstruction, a Scientific Approach to Labour Problems".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL OF THE FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. E. Capstick: "The Nation's Milk Supply and its Best Use".

TEXTILE INSTITUTE, MIDLANDS SECTION (at Coventry), at 7 p.m.—Mr. L. H. C. Tippett: "Quality Control in the Textile Industry".

Thursday, January 30

IMPERIAL INSTITUTE, MINERAL RESOURCES DEPARTMENT (in the Chema Hall, Imperial Institute (East Entrance), South Kensington, London, S.W.7) at 3 p.m.—Mr. J. H. Harris: "A Metallurgist in Tanganyika".*

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. D. J. Finney: "Principles of Biological Assay".

CHEMICAL SOCIETY, SHEFFIELD SECTION (joint meeting with the SHEFFIELD UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. J. B. Speakman: "Some Relationships between the Structure and Properties of Natural and Synthetic Fibres".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. L. H. A. Carr: "The Teaching of the Principles of Electrical Machine Design".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Air Marshal the Hon. Sir Ralph Cochrane, K.B.E.: "War-time Developments in Air Transport".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Princes Gate, London, S.W.7), at 7 p.m.—Mr. N. McQueen: "Animation in Scientific Films".

SOCIETY OF DYERS AND COLOURISTS, BRADFORD JUNIOR BRANCH (at the Technical College, Bradford), at 7.15 p.m.—Mr. E. Yeadon: "Cotton Dyeing".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Outlook in the Social Sciences" (Speakers: Prof. Michael Poston, Prof. T. S. Simey and Prof. S. Zuckerman, F.R.S.).

PHARMACEUTICAL SOCIETY, MANCHESTER, SALFORD AND DISTRICT BRANCH (in the Lecture Theatre, St. Mary's Hospital, Manchester), at 7.45 p.m.—Mr. R. N. Bomback: "Modern Development in Photography".

Friday, January 31

CHEMICAL SOCIETY, ST. ANDREWS AND DUNDEE SECTION (in the Chemistry Department, University College, Dundee), at 7 p.m.—Dr. W. G. Campbell: "Modern Trends in the Chemical Utilisation of Wood".

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Sir Edward Appleton, F.R.S., and Mr. R. Naismith: "The Radio Detection of Meteor Trails and Allied Phenomena"; Mr. J. S. Hey and Mr. G. S. Stewart: "Radar Observations of Meteors"; Dr. E. Eastwood and Mr. K. A. Mercer: "A Study of Transient Radar Echoes from the Ionosphere including Observations made during the Solar Eclipse of July 1945"; Dr. A. C. B. Lovell, Mr. C. J. Banwell and Mr. J. A. Clegg: "Radio Echoes from Meteors".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Dr. Ad. Meyer: "Marine Gas Turbine".

ROYAL STATISTICAL SOCIETY, LONDON GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. B. P. Dudding: "Control Charts Applied to Sales Data".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Manchester Society of Architects, 16 St. Mary's Parsonage, Deansgate, Manchester), at 6.45 p.m.—Dr. J. M. Rodgers: "Significance in the Interpretation of Test Data".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. K. Rideal, F.R.S.: "Thin Films on Water".

Saturday, February 1

INSTITUTE OF PHYSICS, SOUTH WALES BRANCH (at University College, Cardiff), at 3 p.m.—Dr. L. J. Comrie: "Some Applications of Calculating Machines".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN PHYSIOLOGY, and a LECTURER IN PHYSICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (January 31).

PRINCIPAL OF THE ROYAL TECHNICAL COLLEGE, Salford—The Correspondent to the Governors, Education Office, Chapel Street, Salford, Lancs. (February 1).

CHAIR OF MATHEMATICS tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 4).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT, South-East London Technical Institute, Lewisham Way, London, S.E.4—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (February 8).

TEACHER OF PHYSICS up to H.N.C. standard—The Principal, Technical College, Corporation Street, Preston (February 8).

TEACHER OF ZOOLOGY AND BOTANY for Day and Evening Classes at Norwood Technical Institute, Knights Hill, London, S.E.27—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (February 8).

SENIOR LECTURERS AND LECTURERS IN SCIENCE (BIOLOGY and GENERAL SCIENCE) and MATHEMATICS at the Royal Military Academy, Sandhurst—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1780 (February 12).

FOREST ENTOMOLOGIST (male) at the Forest Research Station, Alice Holt, Farnham, Surrey, under H.M. Forestry Commission—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1657.A (February 14).

PHYSICISTS or ELECTRICAL ENGINEERS for research and development work on telecommunications, radar and supersonics—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting A.6/47.A (February 14).

PRINCIPAL SCIENTIFIC OFFICER for research in animal nutrition with special reference to the metabolism of ruminants—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (February 15).

LECTURER IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (February 17).

REGIUS PROFESSOR OF PHYSIOLOGY at Glasgow University—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (February 20).

LECTURER (part-time) IN PSYCHOLOGY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (February 20).

LECTURER (junior) IN THE PHYSICS DEPARTMENT—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W.C.2 (February 21).

SENIOR LECTURER IN GENETICS, a LECTURER IN HORTICULTURE, and a SENIOR LECTURER IN RURAL SOCIOLOGY AND HEAD OF THE DEPARTMENT OF ECONOMICS AND RURAL SOCIOLOGY, at the Canterbury Agricultural College, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.2 (February 25).

SENIOR LECTURESHIPS (2) IN PSYCHOLOGY (one in Psychopathology and the other in Industrial Psychology), and LECTURESHIPS (2, temporary) IN PSYCHOLOGY (in the field of Industrial and General Experimental Psychology), in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.2 (February 25).

PSYCHOLOGIST (temporary) at the Civil Service Selection Board, Stoke d'Abernon—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1779 (February 28).

SECRETARY AND ADMINISTRATIVE OFFICER—The Director of Research, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, Surrey (February 28).

READERSHIP IN ORGANIC CHEMISTRY tenable at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 5).

ANATOMICAL RESEARCH FELLOWSHIP—The Secretary, Zoological Society of London, Regent's Park, London, N.W.8 (April 1).

SENIOR ASSISTANT IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING, a SENIOR ASSISTANT IN THE DEPARTMENT OF CHEMISTRY, a LECTURER IN CHEMISTRY, and a LECTURER IN GEOGRAPHY—The Principal, Technical College, Queen Street South, Huddersfield.

RESEARCH WORKER to investigate the mechanism of learning in various animals (and in the first instance in Octopus)—The Secretary, University College, Gower Street, London, W.C.1.

PROFESSOR OF PURE AND APPLIED MATHEMATICS in the Royal University of Malta—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

PROFESSOR OF PHYSIOLOGY—The Bursar, Royal Veterinary College, Royal College Street, London, N.W.1.
SECRETARY-EDITOR—The Hon. Secretary (Business), Physical Society, 1 Lowther Gardens, London, S.W.7.
JUNIOR DEMONSTRATOR OF PHYSICS—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Health: Nurses Salaries Committee. Revised Recommendations regarding Certain Grades of Nurses. Nurses S. C. Notes, No. 12. Pp. 20. 4*d*. net. Nurses S. C. Notes, No. 13. Pp. 10. 2*d*. net. (London: H.M. Stationery Office, 1946.) [910

City and Guilds of London Institute: Department of Technology. Report on the Work of the Department for the Year 1945. Pp. 72. (London: John Murray, 1946.) 1*s*. net. [910

Ministry of Fuel and Power: Safety in Mines Research Board. Paper No. 104: Intrinsic Safety of Electrical Apparatus; the Minimum Igniting Current in relation to Circuit Constants. By G. Allsop, E. M. Guénault and A. D. I. Nicol. Pp. ii + 15. (London: H.M. Stationery Office, 1946.) 6*d*. net. [910

Scottish Society for Research in Plant-Breeding. Report (abridged) by the Directors and Report by the Director of Research. Pp. 42. (Edinburgh: Scottish Society for Research in Plant-Breeding, 1946.) [910

Department of Scientific and Industrial Research: Fuel Research. Experiments on Coking Practice: the Effect of Type of Oven upon the Properties of the Coke. Pp. iv + 30 + 41 plates. (London: H.M. Stationery Office, 1946.) 4*s*. net. [910

City of Manchester Public Libraries. Annual Report of the Committee, 1945–1946. Pp. 39. (Manchester: Central Library, 1946.) [910

Association of Special Libraries and Information Bureaux. Report of ASLIB Meeting on Indexing and Filing of Unpublished Material. Pp. 36. (London: Association of Special Libraries and Information Bureaux, 1946.) 3*s*. to Members; 4*s*. to non-Members. [910

British Electrical and Allied Industries Research Association. Annotated List of Published Reports. Pp. 112. (London: British Electrical and Allied Industries Research Association, 1945.) 5*s*. [910

Catalogue of Films of General Scientific Interest available in Great Britain. Compiled by the Scientific Film Association. Pp. 188. (London: Association of Special Libraries and Information Bureaux, 1946.) 5*s*. [910

Scientific Instrument Manufacturers' Association of Great Britain, Ltd. Handbook, with Classified Index of Instruments. Pp. 43 + 73. (London: Scientific Instrument Manufacturers' Association of Great Britain, Ltd., 1946.) [910

Forestry Commission. Leaflet No. 14: The Phomopsis Disease of Conifers (*Phomopsis pseudotsugae* Wilson.) Revised edition. Pp. 4. (London: Forestry Commission, 1946.) [910

Society for Freedom in Science. Occasional Pamphlet No. 5: The Future of Science and Technology. By N. S. Hubbard. Pp. 16. (Oxford: Dr. J. R. Baker, University Museum, 1946.) 1*s*. 6*d*. [910

British Rubber Producers' Research Association. Publication No. 70: Kinetic Studies in the Chemistry of Rubber and related Materials, 1. The Thermal Oxidation of Ethyl Linoleate. By J. L. Bolland. Pp. 20. (London: British Rubber Producers' Research Association, 1946.) [910

Agricultural Research Institute of Northern Ireland. Nineteenth Annual Report, 1945–46. Pp. 32. (Hillsborough, Co. Down: Agricultural Research Institute of Northern Ireland, 1946.) [1010

British Standard 7: 1946. Rubber Insulated Cables and Flexible Cords, including Supplement on the Use of Polyvinyl Chloride Compounds as an Alternative to Vulcanised Rubber. Pp. 56. (London: British Standards Institution, 1946.) 3*s*. 6*d*. net. [1010

Other Countries

Caribbean Commission: Committee on Agriculture. Nutrition, Fisheries and Forestry of the Caribbean Research Council. Crop Inquiry Series, No. 1: Livestock in the Caribbean. Pp. xi + 158. Crop Inquiry Series, No. 2: Grasses and Grassland Management in the Caribbean. Pp. ix + 68. (Washington, D.C.: Caribbean Commission, 1945.) [910

Imperial College of Tropical Agriculture: Low Temperature Research Station. Memoir No. 22: Studies in Tropical Fruits, 16, The Distribution of Tannins within the Banana and the Changes in their Condition and Amount during Ripening. By H. R. Barnell and E. Barnell. Pp. 77–100. (Trinidad: Imperial College of Tropical Agriculture, 1945.) [910

Dominion Museum Records in Entomology. Vol. 1, No. 3: A New Spider of the Family Archaeidae from New Zealand. By C. L. Wilton. Pp. 19–26. Vol. 1, No. 4: Collembola—Symphypleona from the Homer District, New Zealand. By Dr. J. T. Salmon. Pp. 27–62. (Wellington: Dominion Museum, 1946.) [910

Parliament of the Commonwealth of Australia. Nineteenth Annual Report of the Council for Scientific and Industrial Research, for the Year ended 30th June 1945. Pp. 164. (Canberra: Commonwealth Government Printer, 1945.) 7*s*. [910

Smithsonian Miscellaneous Collections. Vol. 106, No. 9: The Species of Platycopia Sars (Copepoda, Calanoida.) By Mildred Stratton Wilson. (Publication 3853.) Pp. ii + 16. (Washington, D.C.: Smithsonian Institution, 1946.) [910

Department of Agriculture, Jamaica. Catalogus Insectorum Jamaicensis, Supplement: A List of the Mosquitoes found in Jamaica. By Rolla B. Hill and Claire McDowell Hill. Pp. 4. (Kingston: Government Printer, 1945.) [910

Government of Madras: Education and Public Health Department (Education). Administration Report for 1944–45 of the Government Museum and Connemara Public Library. Pp. 2 + 14. (Madras: Government Printer, 1946.) [910

Indian Forest Leaflet No. 93: The Efficiency of Enumeration. By Dr. A. L. Griffith. 12: One Species in a Mixed Forest (Teak in Madras Moist Mixed Deciduous Forest); 13: Confirmation of the Chir (*Pinus longifolia*) and Sal (*Shorea robusta*) Data; 14: Summary of Indications. Pp. v + 14. (Dehra Dun: Forest Research Institute, 1946.) 5 annas; 6*d*. [91

Annals of the New York Academy of Sciences. Vol. 47, Art. 2. Amino Acid Analysis of Proteins. By William H. Stein, Reginald L. Archibald, Erwin Brand, R. Keith Cannan, Hans T. Clarke, John T. Edsall, G. L. Foster, Stanford Moore, David Shemin, Esmond E. Snell and Hubert B. Vickery. Pp. 57–240. (New York: New York Academy of Sciences, 1946.) 2.25 dollars. [91

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 63: Technological Reports on Standard Indian Cottons, 1945. By Dr. Nazir Ahmad. Pp. iv + 107. 1.8 rupees. Technological Bulletin, Series A, No. 64: Technological Reports on Trade Varieties of Indian Cottons, 1945. By D. L. Sen. Pp. viii + 96. 1.8 rupees. (Bombay: Indian Central Cotton Committee, 1945.) [1010

Trinidad and Tobago. Administration Report of the Conservator of Forests for the Year 1945. Pp. 4. (Trinidad: Government Printer, 1946.) 12 cents. [1010

Department of Public Instruction: Technical Education Branch, New South Wales. Director's Annual Report of the Technological Museum for the Year ended 31st December 1945. Pp. 4. (Sydney: Government Printer, 1946.) [1010

Sveriges Geologiska Undersökning. Ser. C, No. 468: Studier över elementfördelningen i zinkbländen från svenska fyndorter. Av Olof Gabrielson. Pp. 52. 2 kr. Ser. C, No. 469: Arsenic-Cobalt-Nickel-Silver Veins in the Linkaköld Copper Mine, N. Sweden. By Sven Gavelin. Pp. 18 + 11 plates. 0.50 kr. Ser. C, No. 470: A Nickel-Cobalt-Silver-Mineralization in the Laver Copper Mine, N. Sweden. By Olof H. Odman. Pp. 10 + 10 plates. 0.50 kr. Ser. C, No. 471: Dubbla moränan i Boliden. Av G. Lundquist. Pp. 10. 0.50 kr. Ser. C, No. 472: Determinations of the Magnetic Susceptibility of Ores and Rocks from Swedish Iron Ore Deposits. By Sture Werner. Pp. 79. 3 kr. Ser. C, No. 473: Om fynd av mammut vid Pilgrimstad i Jämtland. Av Oskar Kulling. Pp. 64 + 4 plates. 2 kr. Ser. C, No. 474: Arvids-jamfältet och dess förhallände till omgivande berggrund. Av Erland Grip. Pp. 31 + 1 plate. 2 kr., Ser. C, No. 475: The Composition of Eckermannite and its Position in the Amphibole Group. By N. Sundius. Pp. 7. 0.50 kr. Ser. C, No. 476: Skredet vid Såveån den 18 januari 1945. Av Carl Caldenius. Pp. 14 + 3 plates. 0.50 kr. (Stockholm: P. A. Norstedt and Söner, 1945–1946.) [1010

Proceedings of the American Philosophical Society. Vol. 90, No. 4, September 13, 1946: Symposia on Present Day Social and Economic Aspects of National Health and UNESCO and American Participation in its Activities. Papers read before the American Philosophical Society, Annual General Meeting, April 18–19, 1946. Pp. 247–318. (Philadelphia: American Philosophical Society, 1946.) [1010

Supplement to the American Ephemeris, 1947: Total Eclipse of the Sun, May 20, 1947. Pp. 48. (Washington, D.C.: Government Printing Office, 1946.) 25 cents. [1010

Sveriges Geologiska Undersökning. Årsberättelse för år 1945. Pp. 7. (Stockholm: P. A. Norstedt and Söner, 1946.) [1010

Annals of the New York Academy of Sciences. Vol. 48, Art. 1: The Limitations of Optical Image Formation. By Max Herzberger. Pp. 30. (New York: New York Academy of Sciences, 1946.) 75 cents. [1010

Transactions of the San Diego Society of Natural History. Vol. 11, No. 1: The Gopher Snakes of Baja California, with Description of New Subspecies of *Pituophis catenifer*. By Laurence M. Klauber. Pp. 40 (2 plates). Vol. 11, No. 2: A New Gopher Snake (*Pituophis*) from Santa Cruz Island, California. By Laurence M. Klauber. Pp. 41–48 (Plate 3). (San Diego, Calif.: San Diego Society of Natural History, 1946.) [1010

Carnegie Institution of Washington: Department of Terrestrial Magnetism. Publication 568: Scientific Results of Cruise VII of the *Carnegie* during 1928–1929 under Command of Capt. J. P. Ault. Oceanography 3: Ocean Atmospheric-Electric Results. By O. W. Torreson, O. H. Gish, W. C. Parkinson and G. R. Wait. Pp. vii + 178. (Washington, D.C.: Carnegie Institution, 1946.) 2.25 dollars. [1010

U.S. Office of Education: Federal Security Agency. Bulletin 1946, No. 3: Education in Peru. By Cameron D. Ebaugh. Pp. vii + 91. 20 cents. Bulletin 1946, No. 5: How to Build a Unit of Work. By Asst. Prof. Ruth G. Strickland. Pp. iv + 48. 15 cents. (Washington, D.C.: Government Printing Office, 1946.) [1410

Smithsonian Miscellaneous Collections. Vol. 106, No. 6: The Nonmarine Mollusks of San José Island, with Notes on those of Pedro González Island, Pearl Islands, Panamá. By J. P. E. Morrison. (Publication 3850.) Pp. ii + 49 + 3 plates. Vol. 106, No. 13: A New Carnivorous Dinosaur from the Lance Formation of Montana. By Charles W. Gilmore. (Publication 3857.) Pp. ii + 19 + 4 plates. (Washington, D.C.: Smithsonian Institution, 1946.) [141

New Zealand. Twentieth Annual Report of the Department of Scientific and Industrial Research. Pp. 110. (Wellington: Government Printer, 1946.) 2*s*. [211

Dominion Museum Records in Ethnology. Vol. 1, No. 1: Carved Houses of Te Arawa. By W. J. Phillips. Pp. 46. (Wellington: Dominion Museum, 1946.) [211

Sudan Government: Wellcome Chemical Laboratories, Sudan Medical Service, Khartoum. Report of the Government Analyst for the Year 1944. Pp. 11. (Khartoum: Wellcome Chemical Laboratories, 1946.) [211

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 195: An Account of Experiments undertaken to Determine the Natural Population Density of the Sheep Blowfly *Lucilia cuprina* Wied. By Darcy Gilmour, D. F. Waterhouse and G. A. McIntyre. Pp. 39 + 3 plates. (Melbourne: Government Printer, 1946.) [241

Scientific and Technical Aspects of the Control of Atomic Energy. Pp. v + 42. (Lake Success, N.Y.: United Nations Department of Public Information; London: H.M. Stationery Office, 1946.) 2 cents; 1*s*. [241

Second Symposium on the Structure and Properties of Diamond. Pp. iii + 197 + 23 plates. (Bangalore: Indian Academy of Sciences, 1946.) [241